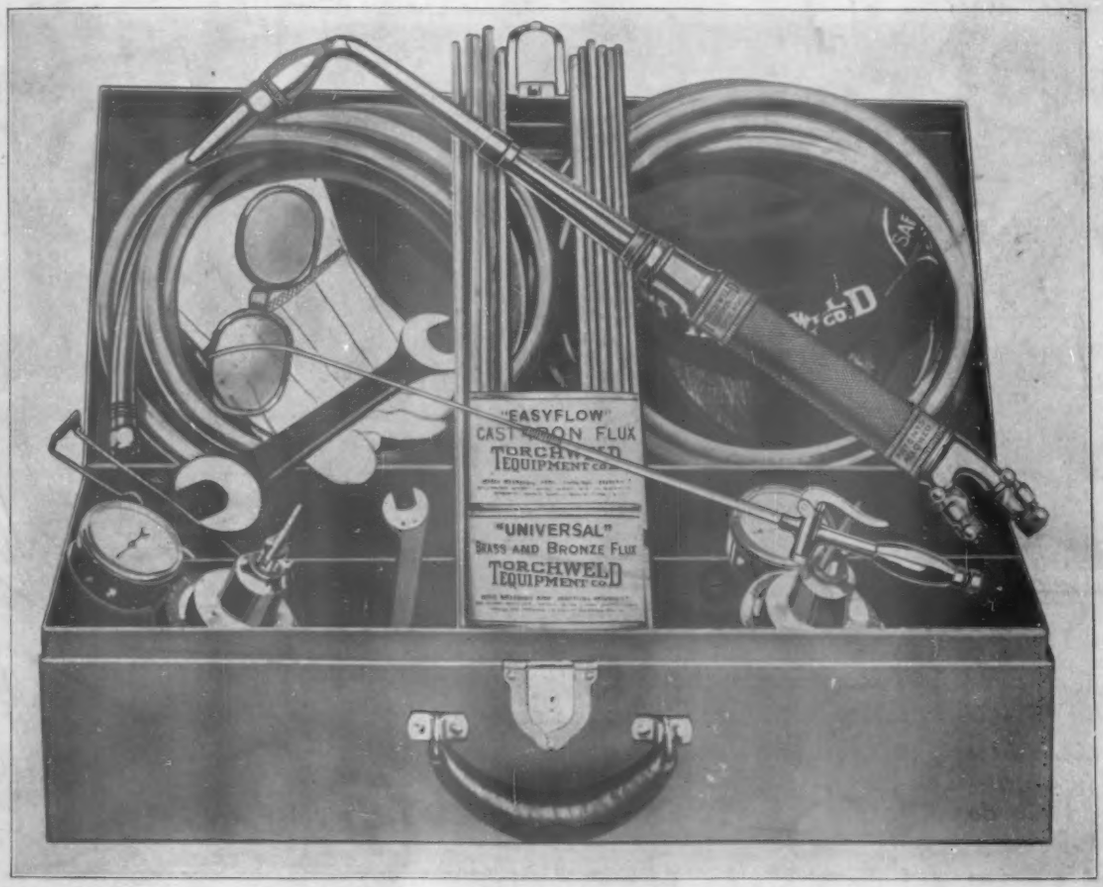
Official Organ of the American Welding Society

The Welding Engineer

Edited by L. B. Mackenzie

$3.00 per year in U. S. | Reg. U. S. Pat. Office | $4.00 per year abroad

Vol. 7 | Chicago | JANUARY, 1922 | 608 S. Dearborn St. | No. 1



Torchweld Standard Welding & Decarbonizing Outfit Complete With Steel Carrying Case, $75.00

For Garage and Machine Shop

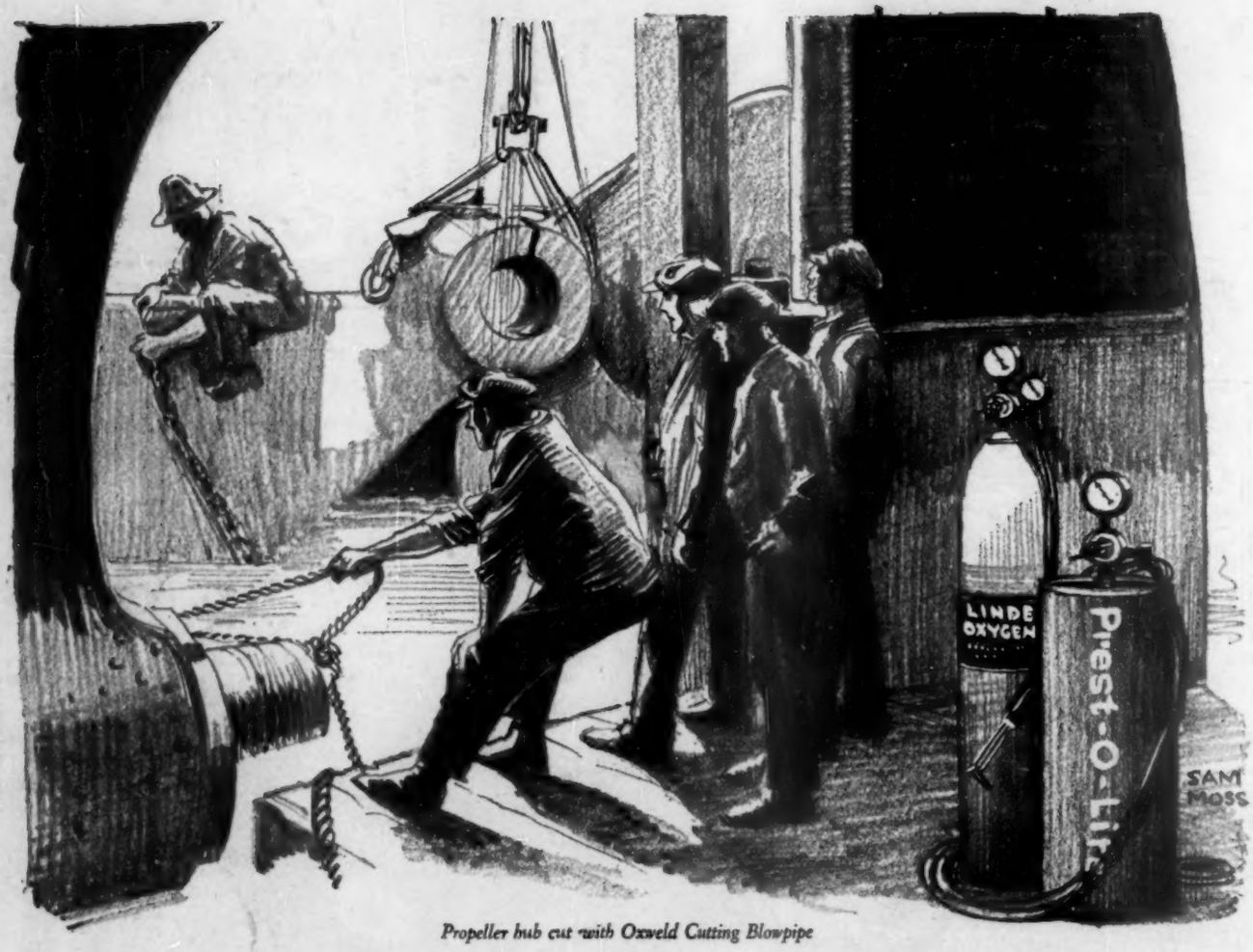
This Outfit Includes—

No. 2 N. F. TORCHWELD Standard Welding Torch, 15 in. long.
TORCHWELD Standard Welding Tips, Nos. 1, 3, 4, 6, 8.
TORCHWELD Standard Decarbonizing Torch.
TORCHWELD Standard 3 inch Oxygen Regulator, with 30 lb. Gauge.
TORCHWELD Standard 3 inch Acetylene Regulator, with 30 lb. Gauge.
TORCHWELD Standard 12½ Ft. Length Each 3 Ply Oxygen and Acetylene Hose, Rods and Fluxes.
TORCHWELD Regulator and Torch Wrench.
TORCHWELD Welder's Cap and Instruction Book.
TORCHWELD Gloves and Spectacles.
TORCHWELD Spark Lighter.
TORCHWELD Steel Carrying Case.

SEND AT ONCE FOR SPECIAL INFORMATION

TORCHWELD EQUIPMENT COMPANY 222 N. Carpenter St., Chicago, Ill.

Published Monthly by the Welding Engineer Publishing Co. Entered as Second Class Matter Jan. 20, 1916, at the Post Office at Chicago, Ill., Under the Act of March 3, 1879.



Propeller hub cut with Oxweld Cutting Blowpipe

It Couldn't Be Done—So They Did It

What Oxweld has done for others—Oxweld can do for you.

An illustrated book "Oxweld Can Do It" tells what oxwelding is doing—write for it

Accomplishing the seemingly impossible is common practice among Oxweld Service Engineers.

After hours spent in vainly trying to wedge this broken propeller from its shaft—after more hours wasted in trying to expand the partially submerged metal—an Oxweld Service Engineer was summoned to the job and in twenty-five minutes the cast iron hub had been cut thru and the shaft freed.

But emergency work such as this forms but a small part of Oxweld usefulness.

In hundreds of plants the oxwelding and cutting blowpipes are making better products at reduced cost and in less time and everywhere the process is eliminating manufacturing delays by remaking worn and broken machinery on the spot with scarcely any lost time.

Oxweld Service Engineers (stationed in more than fifty important cities) will tackle your problems upon request and without charge.

Write for an illustrated book "Oxweld Can Do It."

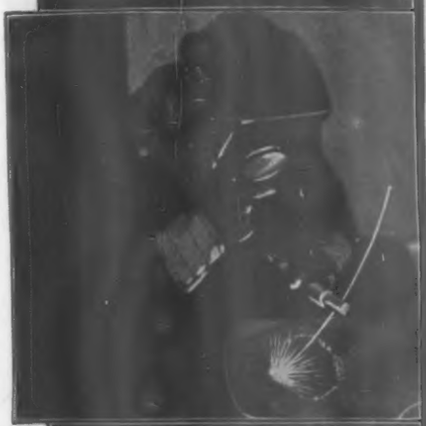
OXWELD ACETYLENE COMPANY · *Newark, N. J.* · *Chicago* · *San Francisco*

Sales Representatives in the Principal Cities of the World

WORLD'S LARGEST MAKER OF EQUIPMENT FOR OXWELDING AND CUTTING METALS

1280-22

One Analysis of Welding Material



For Gas or Electric Welding of Commercial Steel Plates, Castings, Etc.

Armco is a purer iron than Swedish Iron which, since the first commercial application of Gas Welding has been the Welding standard.

Armco Iron deposited by the Electric arc loses none of its elements whereas a steel Electrode will lose approximately 80% of its elements, its carbon deposit being similar to that of Armco.

The higher the carbon content of Welding rods or Electrodes, the greater the possibility of absorbed gases in the weld.

Page-Armco Welding Rods made from Armco Iron fulfill all requirements of the American Welding Society's specifications.

Page Steel & Wire Co.

Bridgeport, Connecticut

DISTRICT SALES OFFICES:

CHICAGO NEW YORK PORTLAND, ORE.
SAN FRANCISCO PITTSBURGH

MANUFACTURERS OF

RODS—Ingot Iron and Special Analysis Steels.
WIRE—Plain and Galvanized—Spring, Rope, Telephone, Telegraph.
FENCE—Woven—Right-of-way and Farm-Chain Link, Factory Partitions, Gates.

Carried in stock by distributors in all industrial centers

PAGE ARMCO WELDING RODS *and* ELECTRODES

INGOT IRON

Buyers' Index

Readers of The Welding Engineer will find this index to contain the most accurate information obtainable relating to welding apparatus and supplies. The advertising section includes the principal manufacturers of the United States.

ACETYLENE (Compressed in Cylinders)
Air Reduction Sales Co.
Commercial Acetylene Supply Co.
Linde Air Products Co.
Universal Oxygen Co.
Prest-O-Lite Co.

ACETYLENE GENERATORS
Air Reduction Sales Co.
Bastian-Blessing Co.
Carbic Mfg. Co.
Davis-Bournonville Co
Imperial Brass Mfg. Co.
Alexander Milburn Co.
Modern Engineering Co.
Oxweld Acetylene Co.
Smith's Inventions, Inc.
Superior Oxy-Acetylene Machine Co
United States Welding Co.
Universal Oxygen Co.

ADVERTISING SERVICE FOR WELDERS
Welding Promotion Co.

ALUMINUM FILLER RODS
Air Reduction Sales Co.
Burdett Oxygen Co.
Wm. Cramp & Sons
Electric Arc Cutting & Welding Co.
Iron City Foundry Co.
Davis-Bournonville Co.
The Imperial Brass Mfg. Co.
Hauck Mfg. Co.
Imperial Brass Co.
Modern Engineering Co.
Oxweld Acetylene Co.
Superior Oxy-Acetylene Mach. Co
Torchweld Equipment Co.
United States Welding Co.
Universal Oxygen Co.

ALUMINUM FLUX
Air Reduction Sales Co.
Burdett Oxygen Co.
Davis-Bournonville Co.
The Imperial Brass Mfg. Co.
Hauck Mfg. Co.
Hoskins Process Development Co.
Imperial Brass Co.
Modern Engineering Co.
Morey Flux & Chemical Co.
Oxweld Acetylene Co.
Superior Oxy-Acetylene Machine Co
Torchweld Equipment Co.
United States Welding Co.
Universal Oxygen Co.

ALUMINUM SOLDER
Air Reduction Sales Co.
Burdett Oxygen Co.
Liberty Welding Co.

ANNEALING FURNACES
Buffalo Dental Mfg. Co.
General Electric Co.
Universal Oxygen Co.

APRONS (Asbestos)
Chicago Eye Shield Co.
Electric Arc Cutting & Welding Co.
Servicized Products Co.

ASBESTOS GLOVES
Air Reduction Sales Co.
Burdett Oxygen Co.
Chicago Eye Shield Co.
Imperial Brass Mfg. Co.
Servicized Products Co.
Universal Oxygen Co.

ASBESTOS SHEET PAPER
Air Reduction Sales Co.
Burdett Oxygen Co.
Davis-Bournonville Co.
Imperial Brass Mfg. Co.
Oxweld Acetylene Co.
Servicized Products Co.
Superior Oxy-Acetylene Machine Co.
United States Welding Co.
Universal Oxygen Co.

BLOW TORCHES (Acetylene)
See "Torches"

BOOKS (Relating to Welding)
The Welding Engineer
Electric Arc Cutting & Welding Co.

BRASS AND BRONZE FLUX
Air Reduction Sales Co.
Burdett Oxygen Co.

Rochester Welding Works

We not only do welding, but supervise the design and installation of oxy-acetylene welding plants; report on welding material and methods; make tests on welding apparatus for efficiency and economy.

Nine years' experience.

Rochester Welding Works
349 Orchard St., Rochester, N.Y.
S. W. MILLER, M. E., Proprietor

Unusual Welding Problems

are an everyday occurrence in our shop. We go anywhere, take the big and little jobs. We use Oxy-Acetylene and Electric Arc processes.

Boiler Welding and special tanks our specialty. Our ten-ton crane handles big work with ease.

Telephone or write for particulars.

Chicago Welded Products Co.
226 N. Carpenter St., Chicago

Hauck Mfg. Co.
Davis-Bournonville Co.
The Imperial Brass Mfg. Co.
Modern Engineering Co.
United States Welding Co.
Oxweld Acetylene Co.
Smith's Inventions, Inc.
Superior Oxy-Acetylene Machine Co.
Torchweld Equipment Co.
Universal Oxygen Co.

BRASS SPELTER WIRE
Air Reduction Sales Co.
Burdett Oxygen Co.
Universal Oxygen Co.
Torchweld Equipment Co.

BRAZING OUTFITS
Alexander Milburn Co.
Bastian-Blessing Co.
Buffalo Dental Mfg. Co.
Hauck Mfg. Co.
Fidelity Brass Mfg. Co.
Imperial Brass Mfg. Co.
Smith's Inventions, Inc.
Superior Oxy-Acetylene Machine Co
Torchweld Equipment Co.

BRONZE FILLER RODS
Air Reduction Sales Co.
Central Steel & Wire Co.
Wm. Cramp & Sons
Electric Arc Cutting & Welding Co.
Burdett Oxygen Co.
Hauck Mfg. Co.
Davis-Bournonville Co.
The Imperial Brass Mfg. Co.
Modern Engineering Co.
Oxweld Acetylene Co.
Superior Oxy-Acetylene Machine Co
Torchweld Equipment Co.
United States Welding Co.
Universal Oxygen Co.

CABLE (For Leads)
Electric Arc Cutting & Welding Co.
General Electric Co.
Quasi-Arc Weldtrode Co.
Transportation Engineering Corp.

CARBIDE (Calcium)
Air Reduction Sales Co.
American Carbolite Sales Co.
Gas Tank Recharging Co.
Shawinigan Products Corp.
Union Carbide Sales Co.

CARBIDE (Compressed in Cakes)
Carbic Mfg. Co.

CARBON (Blocks, Paste, Etc.)
National Carbon Co.
U. S. Welding Co.
Electric Arc Cutting & Welding Co.

CARBON REMOVING TORCHES
See "Torches"

CAST IRON FILLER RODS AND FLUX
Air Reduction Sales Co.
Burdett Oxygen Co.
Bierman-Everett Fdy. Co.
Central Steel & Wire Co.
Chicago Steel & Wire Co.
Wm. Cramp & Sons
B. Dieden Co.
Electric Arc Welding & Cutting Co.
Iron City Foundry Co.
Davis-Bournonville Co.
Hauck Mfg. Co.
International Oxygen Co.
Modern Engineering Co.
North Buffalo Hardware Foundry.
The Imperial Brass Mfg. Co.
Oxweld Acetylene Co.
Imperial Brass Mfg. Co.
Page Steel & Wire Co.
John A. Roebling's Sons Co.
Smith's Inventions, Inc.
Superior Oxy-Acetylene Machine Co
Torchweld Equipment Co.
Transportation Engineering Corp.
United States Welding Co.
Universal Oxygen Co.

COPPER FLUX
Air Reduction Sales Co.
Imperial Brass Mfg. Co.

CUTTING RODS (Elec. Arc)
Electric Arc Cutting & Welding Co.

CYLINDERS
Wm. Wharton, Jr., & Co.

ELECTRIC ARC WELDING OUTFITS
Electric Arc Welding & Cutting Co.
General Electric Co.
Gibb Instrument Co.
Lincoln Elec. Co.
Quasi-Arc Weldrode Co.
Westinghouse Elec. & Mfg. Co.

SERVICE PLANTS

Buffalo, N. Y.
846 Main St.

Chicago, Ill.
1522 Michigan Ave.

Cleveland, Ohio
6529 Euclid Ave.

Milwaukee, Wisconsin
18 Martin St.

Over 500 Licensee Representations
Throughout the World.

Minneapolis, Minn.
14 No. 9th St.

New York, N. Y.
355 W. 57th St.

Pittsburgh, Pa.
5102 Baum Blvd.

San Francisco, Calif.
116 Hyde St.

L. LAWRENCE & COMPANY

Originators of Lawrence Scored Cylinder Process
Beware of Imitators

Home and Licensee Office:

292 Halsey Street NEWARK, NEW JERSEY

Repairs to Scored Cylinders by Lawrence Patented Process are permanent and guaranteed for the life of the motor.

Shop licenses obtainable. Write for particulars and prices today, as someone may be ahead of you.

Distributors of De Luxe Light Weight Gray Iron Pistons, Rebco and Hi-Speed Rings and Wrist Pins.

ELECTRIC RESISTANCE WELDERS. See "Resistance Welding Machines"

ELECTRODE HOLDERS
Electric Arc Welding & Cutting Co.
General Electric Co.
Quasi-Arc Weldtrode Co.
Transportation Engineering Corp.

ELECTROLYTIC OXYGEN AND HYDROGEN GENERATING EQUIPMENT
Burdett Oxygen Co.
International Oxygen Co.
Universal Oxygen Co.

FILLER RODS (Swedish Iron)
Air Reduction Sales Co.
Bierman-Everett Fdy. Co.
Burdett Oxygen Co.
Central Steel & Wire Co.
Chicago Steel & Wire Co.
Wm. Cramp & Sons
B. Dieden Co.
Electric Arc Cutting & Welding Co.
Davis-Bournonville Co.
Hauck Mfg. Co.
Modern Engineering Co.
The Imperial Brass Mfg. Co.
Oxweld Acetylene Co
Page Steel & Wire Co.
Superior Oxy-Acetylene Machine Co.
Transportation Engineering Corp.
Universal Oxygen Co.

FILLER RODS (Tobin Bronze)
Air Reduction Sales Co.
Burdett Oxygen Co.
Central Steel & Wire Co.
Bierman-Everett Fdy. Co.
Davis-Bournonville Co.
International Oxygen Co.
The Imperial Brass Mfg. Co.
Modern Engineering Co.
Oxweld Acetylene Co.
Page Steel & Wire Co.
Superior Oxy-Acetylene Machine Co
Torchweld Equipment Co.
United States Welding Co.
Universal Oxygen Co.

FILLER RODS (Vanadium Steel)
Air Reduction Sales Co.
Burdett Oxygen Co.
Bierman-Everett Fdy. Co.
Central Steel & Wire Co.
Universal Oxygen Co.
Wm. Cramp & Sons
Davis-Bournonville Co.
Hauck Mfg. Co.
International Oxygen Co.
The Imperial Brass Mfg. Co
Modern Engineering Co.
Oxweld Acetylene Co.
Reid-Avery Co.
Torchweld Equipment Co.
Superior Oxy-Acetylene Machine Co.
United States Welding Co.
Universal Oxygen Co.

FIREPROOF PLASTIC
National Carbon Co.
U. S. Welding Co.

FLUE WELDERS (Electric)
General Electric Co.
Wilson Welder & Metals Co.

FLUXES
Air Reduction Sales Co.
Imperial Brass Mfg. Co.
Modern Engineering Co.
Smith's Inventions, Inc.
Universal Oxygen Co.

FURNACES (Annealing)
Buffalo Dental Mfg. Co.
General Electric Co.
Hauck Mfg. Co.
Universal Oxygen Co.

PREHEATING FURNACES
Buffalo Dental Mfg. Co.
Hauck Mfg. Co.
Imperial Brass Mfg. Co.
Modern Engineering Co.
Superior Oxy-Acetylene Machine Co.

GAS BURNERS (Preheating)
Air Reduction Sales Co.
Superior Oxy-Acetylene Machine Co.
Universal Oxygen Co.

GAUGES
U. S. Gauge Co.

GENERATORS (Oxygen or Hydrogen)
Burdett Oxygen Co.
International Oxygen Co.
Universal Oxygen Co.

GLOVES (Welders Asbestos)
Burdett Oxygen Co.
Chicago Eye Shield Co.
Davis-Bournonville Co.
Electric Arc Cutting & Welding Co.
International Oxygen Co.
Imperial Brass Mfg. Co.
Servicised Products Co.
Torchweld Equipment Co.

GOGGLES
Chicago Eye Shield Co
Imperial Brass Mfg. Co.
Modern Engineering Co
Quasi-Arc Weldtrode Co.
Transportation Engineering Corp.

GRINDING MACHINES
N. A. Strand Co.
Transportation Engineering Corp.
Wodack Electrical Tool Corporation.

HARDENING FURNACES
Buffalo Dental Mfg. Co.
General Electric Co.
Hauck Mfg. Co.

HOSE (Oxygen and Acetylene)
Air Reduction Sales Co.
Burdett Oxygen Co.
Buffalo Dental Mfg. Co.
Davis-Bournonville Co.
International Oxygen Co.
Imperial Brass Mfg. Co.
K-G Welding & Cutting Co.
Oxweld Acetylene Co.
Smith's Inventions, Inc.
Superior Oxy-Acetylene Machine Co
Torchweld Equipment Co.
United States Welding Co.
Universal Oxygen Co.

HOSE UNIONS
Air Reduction Sales Co.
Bastian-Blessing Co.
Fidelity Brass Mfg. Co.
K-G Welding & Cutting Co.
Hauck Mfg. Co.
Imperial Brass Mfg. Co.
International Oxygen Co.
Smith's Inventions, Inc.
Superior Oxy-Acetylene Machine Co.
Torchweld Equipment Co.
Universal Oxygen Co.

HYDROGEN
Burdett Oxygen Co.
California Compressed Gas Co.
Gas Products Association
International Oxygen Co.
Universal Oxygen Co.

HYDROGEN PLANTS
Burdett Oxygen Co.
International Oxygen Co.
Universal Oxygen Co.

KEROSENE PREHEATING TORCHES
Air Reduction Sales Co.
Hauck Mfg. Co.
The Imperial Brass Mfg. Co.
Imperial Brass Mfg. Co.
Modern Engineering Co.
Oxweld Acetylene Co.
Smith's Inventions, Inc.
Superior Oxy-Acetylene Machine Co.

NEEDLE VALVES
Air Reduction Sales Co.
Burdett Oxygen Co.
The Bastian-Blessing Co.
Fidelity Brass Mfg. Co.
Universal Oxygen Co.
Buffalo Dental Mfg Co.
Federal Brass Works.
General Welding & Eqpt. Co.
The Imperial Brass Mfg. Co.
K-G Welding & Cutting Co.
Smith's Inventions, Inc.
Superior Oxy-Acetylene Machine Co.
Torchweld Equipment Co.

NITROGEN
Air Reduction Sales Co.
Linde Air Products Co.

OIL BURNERS (Preheating)
Air Reduction Sales Co.
Gas Products Assn.
The Imperial Brass Mfg. Co.
Modern Engineering Co.
Oxweld Acetylene Co.
Superior Oxy-Acetylene Machine Co.

OXY-ACETYLENE CUTTING MACHINES
Davis-Bournonville Co.
The Shawver Co.

OXYGEN (Compressed in Cylinders)
Air Reduction Sales Co.
Burdett Oxygen Co.
California Compressed Gas Co.
Gas Products Ass'n.
International Oxygen Co.
The Linde Air Products Co.
Swift & Co.
Universal Oxygen Co.

OXYGEN AND HYDROGEN GENERATING EQUIPMENT
Burdett Oxygen Co.
Gas Products Assn.
International Oxygen Co.
Universal Oxygen Co.

PREHEATING FURNACES (Artificial or Natural Gas and Oil Fuel)
Imperial Brass Mfg. Co.

PRESSURE GAUGES
Air Reduction Sales Co.
Alexander Milburn Co.
Bastian & Blessing Co.
Burdett Oxygen Co.
Davis-Bournonville Co.
Fidelity Brass Mfg. Co.
Hauck Mfg. Co.
International Oxygen Co.
The Imperial Brass Mfg. Co.
Modern Engineering Co.
Oxweld Acetylene Co.
Smith's Inventions, Inc.
Superior Oxy-Acetylene Machine Co.
U. S. Gauge Co.
Torchweld Equipment Co.
United States Welding Co.
Universal Oxygen Co.

REGULATING VALVES (Acetylene)
Air Reduction Sales Co.
The Bastian-Blessing Co.
Burdett Oxygen Co.
Davis-Bournonville Co.
Federal Brass Works
Hauck Mfg. Co.
Fidelity Brass Mfg. Co.
International Oxygen Co.
The Imperial Brass Mfg. Co
K-G Welding & Cutting Co.
Alexander Milburn Co.
Modern Engineering Co.
Oxweld Acetylene Co.
Smith's Inventions, Inc.
Superior Oxy-Acetylene Machine Co
Torchweld Equipment Co.
United States Welding Co.
Universal Oxygen Co.

REGULATING VALVES (Hydrogen)
Air Reduction Sales Co.
The Bastian-Blessing Co.
Burdett Oxygen Co.
Federal Brass Works
Fidelity Brass Mfg. Co.
International Oxygen Co.
The Imperial Brass Mfg. Co.
Alexander Milburn Co.
Modern Engineering Co.
Universal Oxygen Co.
K-G Welding & Cutting Co.
Superior Oxy-Acetylene Machine Co.
Smith's Inventions, Inc.
Torchweld Equipment Co.
Universal Oxygen Co.

REGULATING VALVES (Oxygen)
Air Reduction Sales Co.
The Bastian-Blessing Co.
Federal Brass Works
Imperial Brass Mfg. Co.
Smith's Inventions, Inc.
Universal Oxygen Co.

SAND BLAST
Transportation Engineering Corp.

RESISTANCE WELDING MACHINES
American Electric Fusion Corp.

SCORED CYLINDERS
L. Lawrence & Co.

SEAM WELDERS (Electric)
General Electric Co.

SILVER SOLDER
F. H. Noble & Co.

SOLDERS
Liberty Welding Co.

TORCHES (Oxy-Acetylene Welding and Cutting)
Air Reduction Sales Co.
The Bastian-Blessing Co.
Carbic Mfg. Co.
Burdett Oxygen Co.
Davis-Bournonville Co.
Federal Brass Works
Fidelity Brass Mfg. Co.
International Oxygen Co.
The Imperial Brass Mfg. Co.
K-G Welding & Cutting Co.
Alexander Milburn Co.
Modern Engineering Co.
Oxweld Acetylene Co.
Prest-O-Lite Co.
Smith's Inventions, Inc.
Superior Oxy-Acetylene Machine Co.
The Thermalene Co.
Torchweld Equipment Co.
United States Welding Co.
Universal Oxygen Co.

TORCHES (Oxy-Hydrogen Welding and Cutting)
Air Reduction Sales Co.
The Bastian-Blessing Co.

Texas Headquarters for Welding and Cutting. The Best Equipped Plant in the State.

Southern Welding & Machine Co.
212-14 College Street
San Antonio, Texas

Burdett Oxygen Co.
Davis-Bournonville Co.
Fidelity Brass Mfg. Co.
International Oxygen Co.
The Imperial Brass Mfg. Co.
K-G Welding & Cutting Co.
Alexander Milburn Co.
Modern Engineering Co.
Oxweld Acetylene Co.
Superior Oxy-Acetylene Machine Co.
Smith's Inventions, Inc.
Torchweld Equipment Co.
United States Welding Co.
Universal Oxygen Co

TANK CONNECTIONS (Oxygen and Acetylene Adaptors)
Air Reduction Sales Co.
Fidelity Brass Mfg. Co.
International Oxygen Co.
Alexander Milburn Co.
Smith's Inventions, Inc.
Superior Oxy-Acetylene Machine Co.
The Imperial Brass Mfg. Co.
Torchweld Equipment Co.
Universal Oxygen Co

THERMALENE-GAS
The Triangle Mfg. Co.

THERMIT WELDING
Metal & Thermit Corp.

TORCHES (Gasoline and Kerosene Preheating)
Air Reduction Sales Co.
Buffalo Dental Mfg. Co.
The Imperial Brass Mfg. Co.

UNION CARBIDE

WORLD'S BEST QUALITY—HIGHEST GAS YIELD

ALWAYS PACKED IN BLUE AND GRAY DRUMS

Large stocks of Union Carbide in all regular commercial sizes are carried at each of Union Carbide Sales Company's Warehouses listed below.

Requests for information and special correspondence should be addressed to our New York, Chicago or San Francisco offices.

Generator Sizes of Union Carbide

Packed in 100 Pound Drums

3½ in. x 2	in.	(Lump)
2 in. x ½	in.	(Egg)
1¼ in. x ⅜	in.	(Nut)
¼ in. x 1/12	in.	(Quarter)

For Oxy-Acetylene Welding and Cutting Plants, Acetylene House Lighting Plants, Contractors' Torches and Flare Lights, and numerous other pieces of Acetylene generating apparatus designed for the use of one of these sizes of Carbide.

UNION CARBIDE SALES COMPANY

Peoples Gas Building
Chicago, Ill.

Carbide and Carbon Building
30 East 42nd St.
New York

Balfour Building
California and Sansome Sts.,
San Francisco, Calif.

UNION CARBIDE SALES COMPANY'S WAREHOUSES

Shipments Always Made On Day Orders Are Received

ALABAMA
Birmingham.....1916 Morris Ave.
Mobile.....16 S. Commerce St.
Montgomery.....114 N. Perry St.

ARIZONA
Phoenix.....42 S. Central Ave.

ARKANSAS
Ft. Smith.....123 S. Ninth St.

CALIFORNIA
Fresno.....932 H St.
Los Angeles.....639 Gibbon St.
Sacramento.....217 O St.
San Diego.....Seventh and J Sts.
San Francisco.....Balfour Bldg.

COLORADO
Denver.....Nineteenth and Wazee Sts.

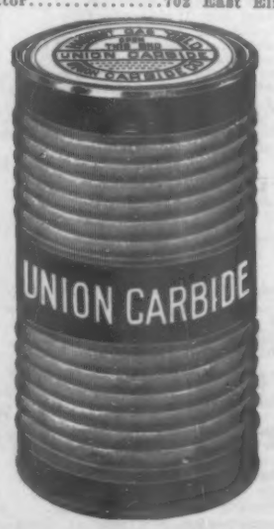
CONNECTICUT
Hartford.....412 Trumbull St.

DISTRICT OF COLUMBIA
Washington.....501 Second St., N. E.

FLORIDA
Jacksonville.....13 Cedar St.
Tampa.....805 Tampa St.

GEORGIA
Atlanta.....P. O. Box 1594
Savannah, Ogeechee Canal, S. of Bay St. P. O. Box 78

ILLINOIS
Chicago.....122 So. Michigan Boulevard
Danville.....511 Oak St.
Decatur.....133 W. William St.
East St. Louis.....700 Broadway
Phones Bell-Bridge 220, Kinloch-St. Clair 320
Marion..315 S. Granite St., P. O. Box 747
Monmouth.....124 E. Archer Ave.
Peoria.....100-110 Edmund St.
Phones Main 700-701, Interstate 7000
Quincy.....313 Delaware St., Phone 320
Springfield.....1801 Washington St.
Streator.....702 East Elm St.



INDIANA
Evansville.....1601 Illinois St.
Fort Wayne.....2216 Broadway
Indianapolis.....110-112 S. Alabama St.
Phones Bell-Main 2410, Independent 27-474
Terre Haute.....921 Wabash Ave.

IOWA
Davenport.....118 Harrison St.
Des Moines.....Third and Elm Sts.
Dubuque.....8th and Washington Sts.
Fort Dodge.....Central Ave. at 16th St.
Ottumwa.....207-9-11 S. Washington St.
Sioux City..925 Fourth St., P. O. Box 398
Waterloo.....1209 East Fourth St.

KANSAS
Pittsburg.....109 W. Third St.
Salina.....154 N. Fifth St.
Wichita....Douglas and Sycamore Aves. P. O. Box 951

KENTUCKY
Allen .....
Louisville.....126 E. Main St.
Middlesboro.....1701 Cumberland Ave.

LOUISIANA
New Orleans.....4124 Toulouse St.

MAINE
Portland.....11 Exchange St.

MARYLAND
Baltimore.....19 E. Lombard St.
Cumberland....53 Third Nat'l Bk. Bldg.
Salisbury...Mill St., Opp. Fulton Station

MASSACHUSETTS
Springfield ..... Napier St.
Worcester..... 15 Federal St.

MICHIGAN
Detroit.....Federal and Junction Aves.
Grand Rapids..500 Shawmut Ave., N. W.
Hancock.....First Nat'l Bank Bldg.
Iron Mountain.....513 Stephenson Ave.
Jackson.....172 South Water St.
Muskegon.....303 W. Western Ave.
Saginaw.....1830-1840 N. Michigan Ave.
Sault Ste. Marie.....

MINNESOTA
Minneapolis.....334 N. First St.
Phones Nicollet 7121, Tri City-Automatic 38634
Virginia.....413 Chestnut St.

MISSISSIPPI
Vicksburg.....1312 Washington St.

MISSOURI
Kansas City.....1422 St. Louis Ave.
St. Joseph.....920 Sixth St., Sta. "A."
St. Louis.....(See East St. Louis, Ill.)

NEBRASKA
Omaha.....1007-9-11 Jones St.
Union Sta. P. O.

NEW JERSEY
Camden.....West and Clinton Sts.
Newark.....251-55 Ridgewood Ave.

NEW YORK
Albany.....103 Third Ave.
Binghamton.....21 Jarvis St.
Phones Long Distance 467, York State 210, Bell 2450
Buffalo.....1336 Genesee St.
Geneva.....Exchange St. & R. R. Place
Hurleyville .....
Jamaica.....11 New York Ave.
Kingston.....O'Neil St., Near Broadway
Niagara Falls .....
Poughkeepsie.....Smith St. and N. Y., N. H. & H. R. R. Tracks
Utica..... 135 Hotel St.
Watertown..... 438 Court St.
Whitehall..... 22-23 Main St.

NORTH CAROLINA
Charlotte.....205 W. First St.
Wilmington.....13 N. Front St.
Raleigh.....P. O. Box 149

NORTH DAKOTA
Fargo.....Fifth St. and Second Ave.

OHIO
Athens.....Factory and Moore Sts.
Canton.....618 Mulberry Road, S. E.
Cincinnati..67 Plum St., Phone Main 682
Cleveland.....601 The Citizens' Bldg.
Columbus.....310 Dublin Ave.
Dayton.....812-828 E. First St.
Lima.....328 East High St.
Mansfield...40 West Third St., Phone 69
Steubenville.....324-342 N. Seventh St.
Toledo.....414 S. Erie St.
Youngstown.....Jones and Brittain Sts.
Zanesville.....Main and 2nd Sts.

OKLAHOMA
McAlester.....8 N. Main St.
Oklahoma.....4 West Park Place
Tulsa.....1-11 N. Boulder St.

OREGON
Portland.....15th and Hoyt Sts.

PENNSYLVANIA
Beaver..... 359 Beaver St.
DuBois....Weber Ave. and Franklin St.
East Greensburg..Clark and George Sts.
Erie..... 1426 Chestnut St.
Harrisburg.....25 S. Tenth St.
Johnstown, Messenger St. and B. & O. R.R.
Pittsburgh .....
.....1202 Chamber of Commerce Bldg.
Pottsville....Railroad and Sanderson St.
Scranton.....Penn Ave. and Vine St.
Shamokin.....Fifth and Walnut Sts.
Williamsport.....Canal and Court Sts.

SOUTH CAROLINA
Charleston..3 N. Liberty St., Phone 2716

TENNESSEE
Chattanooga .....
...627 Volunteer State Insurance Bldg.
Knoxville.....426 West Depot Ave.
Memphis.....671 South Main St.
Nashville..... 105-107-109 Broadway

TEXAS
Dallas.....Wood and Market Sts.
El Paso..First and Kansas Sts., Phone 50
Houston .....
..Baker and Cedar Sts., P. O. Box 1214
San Antonio.....115 Medina St.
Waco..Thirteenth & Mary Sts., Phone 23

UTAH
Salt Lake City..108 W. Second South St.

VIRGINIA
Lynchburg..... 1324 Commerce St.
Norfolk..... 513 Front St.
Richmond.....18th and Cary Sts.

WEST VIRGINIA
Bluefield.....195 Roanoke St.
Charleston..Broad St. and K. & M. R. R.
Elkins.....Railroad Ave. and First St.
Fairmont ..... "A" St.
Huntington...Seventh Ave. & Eighth St.
Morgantown.....178 Clay St., Phone 20
Wheeling.....42rd and McCulloch St.

WASHINGTON
Seattle.....508 Westlake Ave., North
Spokane..162 So. Post St., Phone Riv-96

WISCONSIN
La Crosse.....Front and King Sts.
Madison..... 513-19 Williamson St.
Milwaukee..... 120 Jefferson St.

UNION CARBIDE IS EASILY OBTAINABLE EVERYWHERE

Weldite Welding Rods

Made from a distinctive wrought iron of great purity and possessing unique welding qualities. Furnished in different grades for Gas or Electric Arc Welding, in coils and cut to length, and in Bare Finish, Coppered or Flux Coated.

Full particulars, prices and samples on request.

Manufactured by

CHICAGO STEEL & WIRE CO.

103rd Street & Torrence Avenue, Chicago, Ill.

Hauck Mfg. Co.
International Oxygen Co.
The Imperial Brass Mfg. Co.
Oxweld Acetylene Co.
The Prest-O-Lite Co.
Superior Oxy-Acetylene Machine Co.
United States Welding Co.
Westinghouse Electric & Mfg. Co.
Burdett Oxygen Co.
Davis-Bournonville Co.
International Oxygen Co.
Kentucky Oxygen-Hydrogen Co.
Modern Engineering Co.
Prest-O-Lite Co.
Smith's Inventions, Inc.
Superior Oxy-Acetylene Machine Co.
Universal Oxygen Co.
The Imperial Brass Mfg. Co.
Torchweld Equipment Co.

TRUCKS (Cylinder Carriers)
Air Reduction Sales Co.
The Bastian-Blessing Co.
Burdett Oxygen Co.
Davis-Burnonville Co.
M. Desmond Mfg. Co.
The Imperial Brass Mfg. Co.
Modern Engineering Co.
Superior Oxy-Acetylene Machine Co.
Torchweld Equipment Co.
United States Welding Co.
Universal Oxygen Co.

VALVES (For Oxygen Cylinders)
Air Reduction Sales Co.
Burdett Mfg. Co.
International Oxygen Co.
Universal Oxygen Co.

WELDING APPARATUS (Electric)
Electric Arc Welding & Cutting Co.
General Electric Co.
Gibb Instrument Co.
Lincoln Elec. Co.
Quasi-Arc Weldtrode Co.
Westinghouse Elec. Mfg. Co.

WELDERS' GLOVES
Air Reduction Sales Co.
Chicago Eye Shield Co.
Electric Arc Cutting & Welding Co.
International Oxygen Co.
The Imperial Brass Mfg. Co.
Transportation Engineering Corp.
Universal Oxygen Co.

WELDERS' GOGGLES
Air Reduction Sales Co.
Burdett Oxygen Co.
The Imperial Brass Mfg. Co.
Chicago Eye Shield Co
International Oxygen Co.
Modern Engineering Co.
Quasi-Arc Weldtrode Co.
Transportation Engineering Corp.
Universal Oxygen Co.

WELDERS MASKS
Chicago Eye Shield Co.
Electric Arc Welding and Cutting Co.
General Electric Co.
Torchweld Equipment Co.
Transportation Engineering Corp.

WELDING RODS AND WIRE
Air Reduction Sales Co.
Electric Arc Cutting & Welding Co.
Bierman-Everett Fdy Co.
Burdett Oxygen Co.
William Cramp & Son
Central Steel & Wire Co.
Chicago Steel & Wire Co.
B. Dieden Co.
Iron City Foundry Co.
The Imperial Brass Mfg. Co.
International Oxygen Co.
Manganese Steel Forge Co.
Modern Engineering Co.
North Buffalo Hardware Foundry.
Oxweld Acetylene Co.
Page Steel & Wire Co.
Quasi-Arc Weldtrode Co.
Reid-Avery Co.
John A. Roebling's Sons Co.
Torchweld Equipment Co.
Transportation Engineering Corp.
Universal Oxygen Co.

WELDING ROD HOLDERS
C. Sorensen.

WIRE AND CABLE (Asbestos Insulated)
Central Steel & Wire Co.
D. & W. Fuse Works, General Electric Co

ALPHABETICAL INDEX TO ADVERTISERS

A
Air Reduction Sales Co..... 59
American Carbolite Sales Co..... 48

B
Bastian-Blessing Co., The.....30-31
Bierman-Everett Fdy. Co..... 58
The Buckeye Welding & Sup. Co..... 58
Buffalo Dental Mfg. Co..... 57
Burdett Mfg. Co..... 51

C
Carbic Mfg. Co..... 42
Central Steel & Wire Co..... 53
Chicago Eye Shield Co..... 53
Chicago Steel & Wire Co..... 8
Chicago Welded Products Co..... 4
Commercial Acetylene Supply Co..... 18
Wm. Cramp & Sons..... 15

D
Davis-Bournonville Co. 17
B. Dieden & Co..... 56
M. Desmond Mfg. Co..... 58

E
Electric Arc Welding & Cutting Co..... 55
Everstay Sales Co..... 56

F
Federal Brass Works..... 17
Fidelity Brass Mfg. Co..... 51

G
General Electric Co..... 33
Gas Products Assn..... 13
Gas Tank Recharging Co..... 14

H
Hauck Manufacturing Co..... 53
Hoskins Process Development Co..... 58

I
Imperial Brass Mfg. Co..... 58
International Oxygen Co..... 10
Iron City Foundry Co..... 58

K
K-G Welding & Cutting Co..... 9

L
Liberty Welding Co.....55, 56
Linde Air Products Co..... 20
Lincoln Electric Co..... 16
L. Lawrence & Co..... 5

M
Manganese Steel Forge Co..... 9
Milburn, The Alexander Co..... 11
Merey Flux & Chemical Co..... 58
Modern Engineering Co..... 19

N
F. H. Noble & Co..... 17
North Buffalo Hardware Foundry..... 55

O
Oxweld Acetylene Co..... 2

P
Page Steel & Wire Co..... 3
The Prest-O-Lite Co., Inc..... 39

Q
Quasi-Arc Weldtrode Co..... 58

R
Reid-Avery Co. 14
Roebling, John A., Sons, Co..... 10
Rochester Welding Wks..... 4

S
The Shawver Co..... 9
C. Sorensen 55
Superior Oxy-Acetylene Machine Co..... 57
Southern Welding Machine Co..... 6
Shawinigan Products Corporation..... 18
Smith's Inventions, Inc..... 10
N. A. Strand & Co..... 58

T
Torchweld Equipment Co.....Front Cover
Transportation Engineering Corp..... 19
Triangle Mfg. Co..... 56

U
Union Carbide Sales Co..... 7
United States Welding Co..... 57

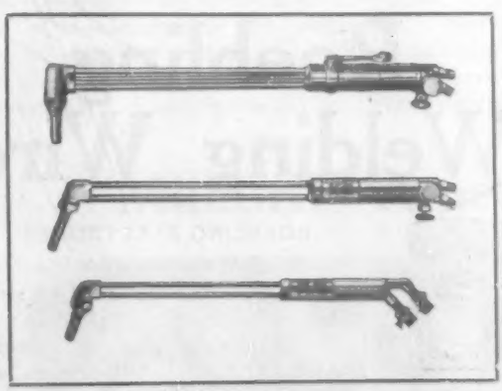
W
Welding Promotion Co..... 57
Welding Service Co..... 57
Westinghouse Elec. Mfg. Co..... 12
Wm. Wharton, Jr., & Co., Inc..... 55
Wodack Electric Tool Corporation..... 56

ROL-MAN MANGANESE STEEL

FOR ELECTRIC WELDING **WELDING RODS** FOR GAS WELDING

The original High Manganese Steel Welding Rod Welds made with Rol-Man are toughest and most wear-resisting. Rol-Man Rods will weld to **Manganese Steel and *STICK*. For building up Carbon or Manganese Electric, Street and Steam Railway Track Work, Rol-Man Rods are unequalled.** ***Sample on request.***

MANGANESE STEEL FORGE CO. Land Title Bldg., **Philadelphia, Pa.**



K-G

Cutting Welding

TORCHES

Any Length Desired
for Any Gas Desired

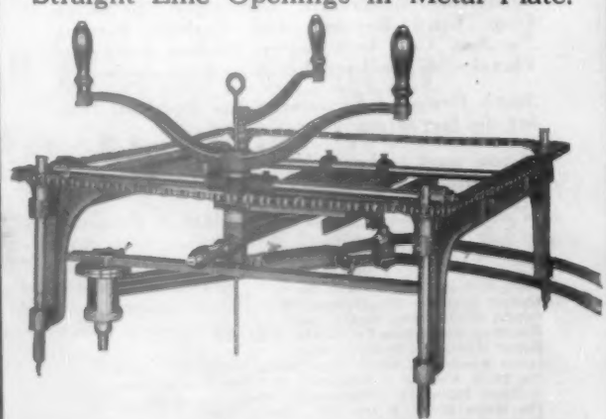
K-G Welding and Cutting Co., Inc.

Home Office and Factory
556 West 34th St., N. Y. City

SALES OFFICES:
Philadelphia, Pittsburgh, Chicago, Springfield, Mass. Norfolk

THE ELLIPSOGRAPH

For Flame Cutting Circular, Elliptical and Straight Line Openings in Metal Plate.



The Ellipsograph (a hand driven machine fitted with 90 degree cutting torch is shown above) is a finer development of the Acetylene Cutting Torch. It is simple and inexpensive to operate. The torch control mechanism is positive and accurate for elliptical, circular or straight lines without the aid of forms, gauges, cams or patterns.

Capacities: Elliptical forms 0 in. to 20 in. x 32 in. Circular Forms 0 in. to 20 in. Straight lines 0 in. to 20 in.
Weight (without Torch) 80 lbs.
Dimensions: 30 in. long, 28 in. wide, 18 in. high.

Send for descriptive folder.

Manufactured by
The Shawver Co. **Springfield, O.**

What do you think of the new Smith Baby?

It's Smith No. 6.—Remember the number.

It's been with us for a little more than a year and for so young a party it's made an army of friends.

And for such a youngster it has a mighty big lot of experience and "know-how" in its makeup. No grown-up has as much.

It's the new Number 6 Smith Welding Torch.

Six torches in one—one for every purpose—every one of them a wonder for doing work quick and easy.

This torch is Elmer Smith's masterpiece, his greatest invention. It is the result of his years and years of study of welding problems, and his hundreds of experiments on all kinds of welding jobs. It is by far the most perfect torch on the market.

It ought to be. Elmer Smith has done more to improve welding processes than any other man—he has a long record of achievement built on real welding experience.

Some of his inventions that have revolutionized and simplified welding operations include Smith's Kerosene Pre-heating Torch, Automatic Acetylene Generators, Acetylene Soldering Iron, Lead Burning and Carbon Burning Torches, Cast Iron Solder, Carbon putty and Fluxes—all the best that have been devised.

Smith Designed Equipment has stood all tests for the last fifteen years.

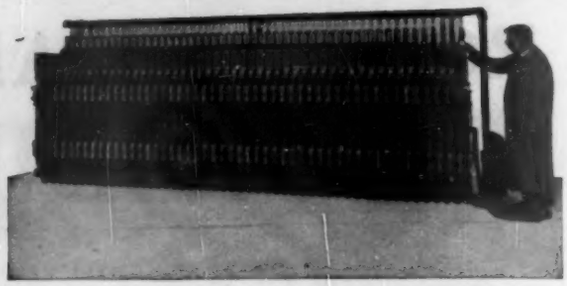
If you want to know how easy it is to be sure of satisfactory welding results, write for information and our latest catalog.

DISTRIBUTORS

Campbell Iron Co., St. Louis, Mo.
Electric Appliance Co., Chicago, Ill.
Omaha Welding Co., Omaha, Nebr.
Bonniwell Calvin Iron Co., Kansas City, Mo.
Holter Hdwe. Co., Spokane, Wash.
James Supply Co., Chattanooga, Tenn.
Big Three Welding & Equipment Co., Fort Worth, Texas.
Williams Hdwe. Co., Minneapolis, Minn.
The Moore Hdwe. & Iron Co., Denver, Colo.
Young & Vann Supply Co., Birmingham, Ala.
Taylor Parker Co., Norfolk, Va.
Motor Mercantile Co., Salt Lake City, Utah.
Seattle Oxygen Co., Seattle, Wash.
Waterhouse & Lester Co., San Francisco, Calif.; Los Angeles, Calif.; Portland, Ore.
Motor Equipment Co., Wichita, Kans.
Shadbolt & Boyd Iron Co., Milwaukee, Wis.
Tull Rubber & Supply Co., Atlanta, Ga.
Mine & Smelter Supply Co., Salt Lake City, Utah.

SMITH'S INVENTIONS INCORPORATED

SMITH'S INVENTIONS INC.
2617 4th St. S. E.
Minneapolis, Minn.



THE PUREST OXYGEN SAVES MONEY SAVES TIME Does Better Work

GAS CONSUMERS MUST CONSIDER

EFFICIENCY in cutting and welding operations
ECONOMY in the application
QUALITY in the finished work

Pure *Oxygen* and Pure *Hydrogen* as produced by the *I. O. C. System* are VITAL FACTORS in such considerations. Over a score of *I. O. C. System Commercial Plants* are ready to supply your requirements from the following points:

Atlanta, Ga.	Indianapolis, Ind.	Pittsburgh
Boston	Louisville, Ky.	Portland, Ore.
Buffalo	Hoboken, N. J.	Salt Lake City
Chicago	Kenosha, Wis.	Tariffville, Conn.
Cleveland	Newark, N. J.	Toledo, Ohio
College Point, N. Y.	New York City	Washington
Dayton, Ohio	Omaha, Nebr.	Youngstown, Ohio
Davenport, Ia.	Peoria, Ill.	

International Oxygen Co.
Newark, New Jersey
London New York Paris

Roebling Welding Wire

ROEBLING ELECTRODES

Roebling Wire Electrodes are supplied in the following standard sizes: ¼-in.; 5/32-in.; 3/16-in.; 7/32-in.; 1/8-in.; 5/32-in., having a standard length of 14-in., in bundles 50 lbs. each, and are always available for quick shipment. Sizes other than the above and as large in diameter as ½-in., having any length required, either straightened or in coils can be furnished on order.

ROEBLING WELDING STICKS

Roebling Wire Gas Welding Sticks are copper coated to distinguish them easily from Roebling Electrodes. They are supplied in standard sizes: 1/16-in.; 5/64-in.; 3/32-in.; 7/64-in.; 1/8-in.; 5/32-in.; 3/16-in.; and in standard lengths of 36 in. in bundles weighing 50 lbs. each, well protected by weatherproof paper or burlap. Sizes other than the above either straightened or in coils can be furnished on order.

JOHN A. ROEBLING'S SONS CO.
TRENTON, N. J.

VICTORY! MILBURN Methods and Appliances are leading

this organization, its agents and customers to greater triumphs every day. Fearless integrity marks everything we undertake. Apparatus of originality and worth backed by our unqualified guarantee has always been our policy. Here are three examples of Milburn achievement:

"Cut-Weld" Cutting and Welding Torch

A victorious double duty oxy-acetylene torch that cuts 18 inch of steel and welds any thickness of metal encountered in practice, by a simple change of tips. It covers the entire range of the welding and cutting art. The "Cut-Weld" torch uses standard Milburn cutting and welding tips. Saves equipment, time, labor and gas. Adopted by leading railroads and government departments. Victorious after years of competitive tests.

Milburn "American" Type Regulator

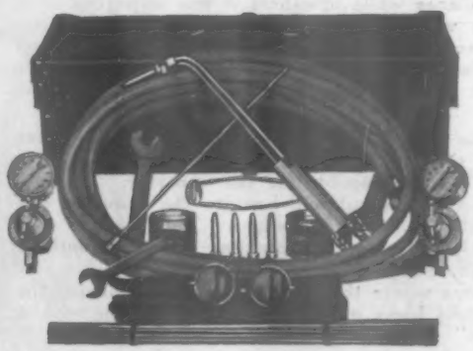
For Control and Delivery of High Pressure Gases

An achievement in controlling high pressure gases, such as oxygen and acetylene in welding and cutting.

It revolutionizes old principles. Valve closes **with** pressure not **against** pressure. Travels in self-aligning sleeve. Result is quicker seating and longer life. Fewer parts than the average regulator. Easily get-at-able. Stands rigorous service.

Milburn "American" Garage Outfit

For Oxy-Acetylene Welding and Carbon Burning



Our latest triumph, a high grade outfit, made to work and to wear. Torch is 16 inches long, light, substantial and well balanced. Welds anything from fenders to cylinder blocks. Fitted with five welding tips and a carbon burning tube, packed in fibre carrying case, with beginner's supply of rods and flux. Nothing more to buy but the gas.

Price, complete outfit, $55.00

(Shipping weight, 24 pounds.)

Emergency cutting tip that cuts up to one inch thickness can be furnished at $2.50 extra.

The Alexander Milburn Company

1420-1428 W. Baltimore Street, Baltimore, Maryland

BRANCHES:

New York	Philadelphia	Chicago	Pittsburgh	San Francisco
Grand Central Palace	Bourse Building	15 E. Van Buren St.	532 Union Arcade	268 Market Street

Desirable Territory Open for Agents

Arc Welding In Honduras, C.A.

3000 feet of 22 in. diameter pipe required repairs in San Jacinto, Honduras. Here is how it was done as told by the chief in charge.

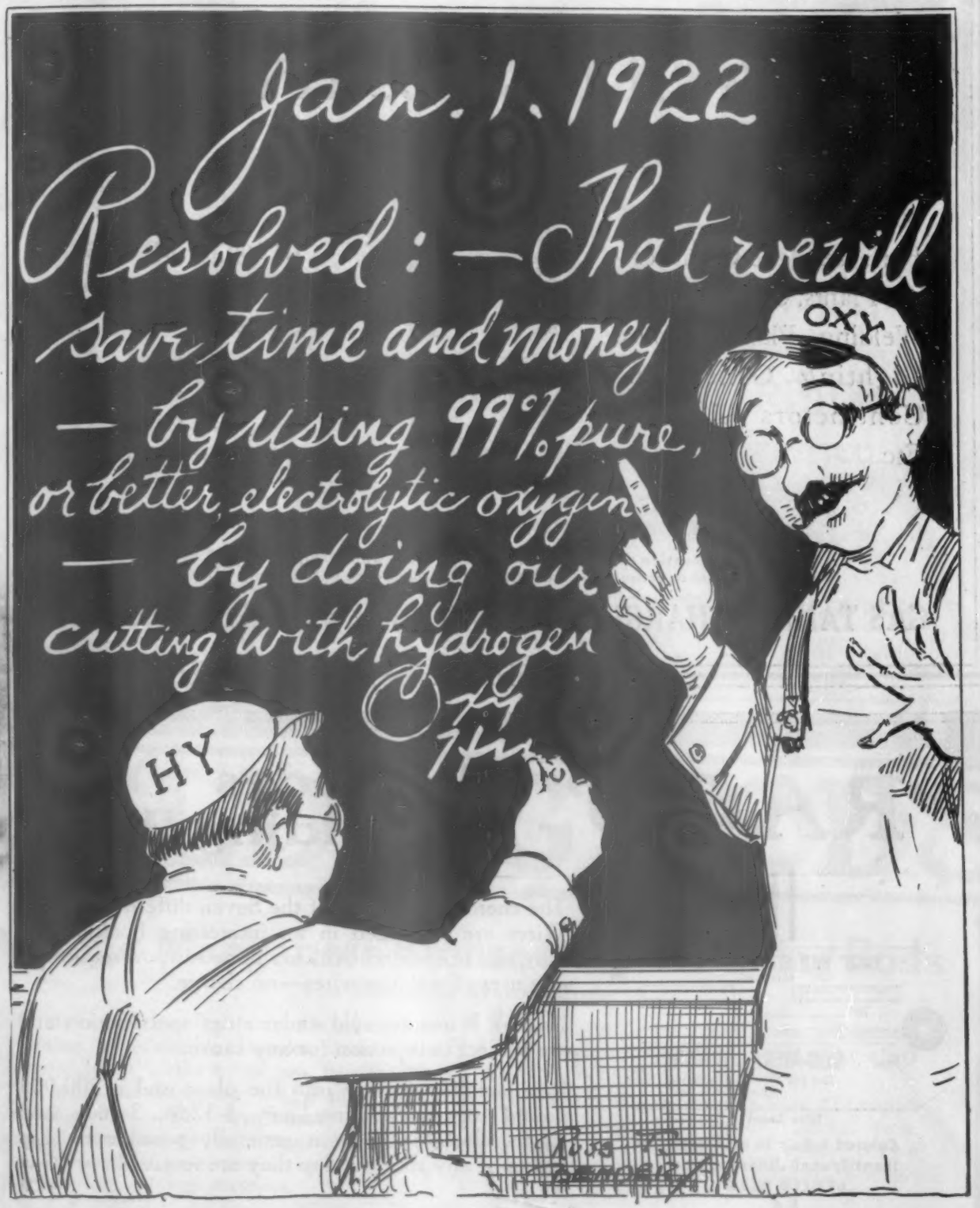
"I need not go into details, it will be sufficient to say that the pipe was as thin as a piece of paper in some places while in others it was in perfect condition. The question arose as to which would be the cheaper, buy a new pipe, or repair the old one, so one of the worst lengths was taken out and repaired with the aid of our Westinghouse welding outfit. The result was we could repair the pipe and make it almost as good as new for one tenth the cost of a new pipe.

"The method employed to repair the pipe was the most simple possible. Three lengths were disconnected so that they could be turned around on the piers to make the welding operation as easy as possible for the operator. The defective places were then marked off, plates cut and bent to the required size and shape, put into place, and welded around the edges. This method may not appeal to some people, but 'the proof of the pudding is in the eating.' The pipe was then tested to double the working pressure and, barring a few beads of moisture appearing in places where the weld was slightly porous, the pipe was otherwise OK. These slight leaks only required a little tap with a hammer to eliminate them entirely."

Westinghouse Arc Welding Equipments are furnished in stationary or portable types for one or more operators and in all sizes from 175 to 1,000 amperes.

Westinghouse Electric & Manufacturing Co.
East Pittsburgh, Pa.
Offices in all principal American Cities

Westinghouse



Electrolytic Oxygen and Hydrogen Plants Everywhere

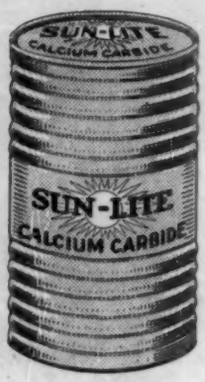
Gas Products Association

801 Marquette Building **Chicago, Ill.**

SUN-LITE CARBIDE

PACKED IN BROWN DRUMS

For Acetylene Compressing Plants, Oxy-Acetylene Welding Plants, House Lighting Generators, Contractors' Torches, Etc.



IN 100 lb. DRUMS

In All Commercial Sizes:

3½" x 2"
2" x ½"
1¼" x ⅜"
¼" x 1/12"

MINERS' LAMP

Write for location of nearest sales agency, from which shipments will be made direct to consumer. Address all correspondence to the Home Office

GAS TANK RECHARGING COMPANY, MILWAUKEE, WISCONSIN

"RACO" Electrodes *and* Welding Wires

Blue Label

Colored labels in this style identify each different kind of RACO WIRE

The chemical analyses of the Seven different "Raco" Wires are published in an interesting booklet, the only one of its kind, which will be sent on request to any user of welding wires—no charge.

"Raco" Wires are sold under strict specification and are subject to rejection for any cause.

Rail facilities directly into the plant and a 500,000 pound stock, in 3-32 in., ⅛ in., 5-32 in., 3-16 in. and ¼ in. diameter make it generally possible to ship orders of any size, the day they are received.

Samples for testing and new current prices furnished promptly.

Reid-Avery Company

21st St. and Washington Ave.
PHILADELPHIA, PA.

Those who have enjoyed long association with CANADIAN CARBIDE have always assumed high standards of performance. We are confident that if not already among the users of CANADIAN CARBIDE the day will come when you too will know the meaning of "More Gas per Pound"

SHAWINIGAN PRODUCTS CORPORATION

110 WILLIAM STREET NEW YORK
549 McCORMICK BLDG. CHICAGO

SHAWINIGAN

WELDING RODS

Parsons' Manganese Bronze Rolled Welding Rods

the Strongest Bronze Made

for high-fire Brazing and Oxy-Acetylene Welding of Malleable Iron or Bronze and Brass castings assure a faultless, flawless job. This is another example of the "Cramp" standard of quality. This scientifically perfected metal is the result of long years of experience. Its fine physical properties make it especially suitable for welding purposes.

A strong weld of fine close grain and exceedingly tough texture is always the result where Cramp's Welding Rods are usesd.

We can also furnish Welding Rods of Cramp's Cast Iron, Cramp's Copper Covered Iron, Cramp's Vanadium Steel, Cramp's Drawn Aluminum, Cramp's Cast Aluminum, Cramp's American Iron and Soft Brass Brazing Wire.

CRAMP

We furnish and will be glad to estimate on all kinds of brass and bronze castings.

The William Cramp & Sons Ship & Engine Building Co., Philadelphia

LINCOLN ARC WELDER

Profitable Work for Commercial Welders

The installation of a Lincoln Arc Welder broadens the line of work a welding shop can do and increases the profit.

Here is the end casting of a 100-ton flanging machine which broke in service and which would have cost the owner $5,000 to replace, including the production time lost while the machine lay idle.

They called in a commercial welder who made the repair with a Lincoln Arc Welder at a net cost to him of about $230 and what is more important, had the machine in working trim in far less time than it could be done in any other way.

This welder charged a good price for his work and earned a well deserved profit on the service due to the speed and economy of his Lincoln Arc Welder.

"Link Up with Lincoln"

The Lincoln Electric Co.

General Offices and Factory, Cleveland, O.

The Lincoln Electric Co., of Canada, Ltd., Toronto-Montreal

This Standard Lincoln Motor operated over 3 years under water without damage.

BRANCH OFFICES:

New York City
Buffalo
Cincinnati
Chicago
Detroit
Columbus
Pittsburgh
Philadelphia
Boston
Charlotte, N. C.
Minneapolis
London, England

Agencies in other Principal Cities

Federal Regulators
Help SELL Your Torches

100% Efficient
Cheapest in the End

Improve Your Torches By Using "Federal" Regulators

"Ask for Catalog"

FEDERAL BRASS WORKS
3100 SOUTH KEDZIE AVENUE, CHICAGO

BRAND **Wire Silver Solder** BEST ON EARTH
Used for Welding and Brazing

"NOBLE" Silver Solder Makes a Perfect Weld of Broken Parts

Sold in 1-Ounce Bundles

Any Size or Thickness

Sold in Sheet Form, Wire Coils and on Spools for Welding or Brazing Steel, Copper, Brass, and Nickel Silver.

MADE IN FIVE DIFFERENT QUALITIES. OUR NO. 8 QUALITY IS INEXPENSIVE AND USED EXTENSIVELY BY WELDING CONCERNS.

Inquiries Appreciated—Samples Furnished Upon Request

F. H. NOBLE & CO. CHICAGO, ILL.
555 W. 59th ST.

Davis-Bournonville

Garage and Small Machine Shop Carrying Case Welding Outfit

A new torch and equipment, packed in a neat fibre case complete is offered at the low price of $55. The outfit consists of the following:

1 Torch, Style No. 7000
3 Extension Tubes
Style No. 7017, 5 in. long
Style No. 7018, 10 in. long
Style No. 7019, 15 in. long
5 Welding Tips
Style 9, sizes assorted from No. 1 to No. 7
1 Decarbonizing Tube
Style No. 7020
1 Oxygen Regulator
Style No. 5500
1 Acetylene Regulator
Style No. 5501
12 ft. Oxygen Hose, with Connections
12 ft. Acetylene Hose, with Connections
1 Sparklighter
1 Pair Colored Glasses
1 Torch Wrench
1 Regulator Wrench

Price complete, packed in fibre case, as shown, $55. An assortment of welding rods and fluxes, necessary for average welding jobs packed in a wooden box, is furnished at $6 extra.

Price of Outfit in Canada $65.

Davis-Bournonville Company

Factory and General Offices:
JERSEY CITY, N. J.

BRANCHES IN PRINCIPAL CITIES

Commercial Acetylene Is the Welder's Standard Specification

"COMMERCIAL" is the Mark of Uniform Purity

The name "Commercial" has been associated with dissolved acetylene since the beginning of oxy-acetylene welding. Commercial Acetylene is favorably known for its reliability, its uniform purity and its organization for service to the industry. The gas is absolutely pure and uniform, enabling the welder to maintain with ease the proper neutral welding flame.

If you buy acetylene you should become familiar with the COMMERCIAL plan. Buying the Commercial way means that you buy gas only—we loan you the cylinders. You USE what's inside the cylinders and that's all you pay for.

Acetylene supplied in portable cylinders of the following sizes and capacities:

10 in. x 30 in.	size	-	125 cu. ft.	capacity
12 " x 36 "	"	-	225 " ft.	"
12 " x 44 "	"	-	275 " ft.	"

Submit your acetylene requirements to our nearest office.

Commercial Acetylene Supply Co.

Main Office: 80 Broadway, New York City
542 S. Dearborn St., Chicago

Atlanta, Ga. — Los Angeles, Calif. — Aurora, Ill.
East Deerfield, Mass. — Boston, Mass. — Toronto, Ont.
San Francisco, Calif. — Bound Brook, N. J. — W. Berkeley, Calif.

Hold on! What were you doing just then? Storing away that interesting bit of welding experience, or a photograph, perhaps? Don't do it? Give it to us. We want to show it to 5,000 other readers of The Welding Engineer (you're the fifty-one hundredth). If there are objectionable features to it, just leave it to the Editor (he studied surgery), cutting off and adding to is his hobby.

Another thing, when you work out a successful solution to a welding problem write us about it. Grammar and composition don't count—it's ideas we want. If a sketch would illustrate your job in good shape, just make a rough pencil sketch; our draughtsman will do the rest.

If the welding industry is to grow, you welders must pass along your experiences. We pay for them.

THE WELDING ENGINEER

608 S. DEARBORN ST., CHICAGO

Wanamaker Coated Electrodes
FOR
ARC WELDING

COATED WANAMAKER ELECTRODES

Reduce your labor costs.
Reduce your current costs.
Reduce your electrode material costs.

Increase your production.
Increase the operators' efficiency.
Increase the quality of your welds.

Write for details.

The new Tecor Specialties Bulletin describes the WANAMAKER COATED ELECTRODES, also a complete line of welding accessories.

Write for it today.

Transportation Engineering Corporation
200 FIFTH AVE., NEW YORK, N. Y.
608 SOUTH DEARBORN ST., CHICAGO, ILL.

AUTOMOBILE WELDING
With the OXY-ACETYLENE FLAME By M. Keith Dunham
167 Pages **Price $1.50** *Fully Illustrated*

This is the only complete book on the "Why" and "How" of Welding

Explains in a simple manner apparatus to be used, its care, and how to construct necessary shop equipment. Proceeds then to the actual welding of all automobile parts, in a manner understandable by everyone.

Gives principles never to be forgotten. Aluminum, cast iron, steel, copper, brass, bronze and malleable iron are fully treated, as well as a clear explanation of the proper manner to burn the carbon out of the combustion head.

Automobile Owners, Garage and Service Stations, Blacksmiths and Machine Shops, as well as industries using the oxy-acetylene flame, will find this book of the utmost value, since the perplexing problems arising when metal is heated to a melting point are fully explained and the proper methods to overcome them shown.

CONTENTS

CHAPTER I.—APPARATUS KNOWLEDGE.
Oxygen Supply—Care of Oxygen Cylinder—Acetylene Generation—Care of Generator—Regulators—Care of Regulator — Creeping Regulators — Gauges—Care of Gauges—Welding Torch—Care of Welding Torch—Effects of Heat—Hose and Goggles.

CHAPTER II.—SHOP EQUIPMENT AND INITIAL PROCEDURE.
Preheating Agencies—Welding Table—Location of Welding Outfit—Starting the Welding Outfit—Adjustment of Flame—Principle of Welding—General Welding Knowledge—Welding Rods and Fluxes—Choice of Tip—Expansion and Contraction.

CHAPTER III.—CAST IRON.
Simple Welding—How to Hold the Flame—Hard Cast Iron—Pin Holes and Blow Holes—Lug on Cylinder—Water Outlet—Cylinder Welding—Compression Head—Finishing and Testing—Scored Cylinders—Cylinder Parts—Fly Wheels—Pistons—Crank Cases — Babbitted Bearings — Valve Guides—Preserving Threads—Conclusion of Cast Iron.

CHAPTER IV.—ALUMINUM.
Use of—Welding Knowledge—Puddle System—Flux System—Comparison of Systems—Welding Rod—Preparation of the Weld—Inlet Manifold—Arm of Crank Case—Welding the Arm Without Taking Out the Motor—Break in the Body of Case—Welding Cold—Wrong Method of Setting Up—Lug or Boss Welding—Preheating the Case—Gas Preheating Flame—One Side or Both—Collapse of Weld—Broken Bearings—Direction of Welding—Shrinkage Cracks—Missing Parts—Finishing—Die Moulded Castings—Body—Other Parts.

CHAPTER V.—STEEL.
Welding Knowledge—What the Flame Does to Steel—The Welding Rod—Simple Welding—Position of Flame—Reinforcing the Weld—Frame Welding—Lengthening the Chassis—Tube Housings—Worn Parts—Gear Welding — Case Hardening — Light Metal Welding—Gasoline Tank—Welding Adjacent to Rivets—Shaft Welding—Construction of Parts.

CHAPTER VI.—MALLEABLE IRON, COPPER, BRASS, BRONZE.
How to Detect Malleable Iron—Brazing Malleable Iron—Rear Housing—Reinforcing the Braze—Brazing Tube to Housing—Building Up Worn Parts—Copper—Brass and Bronze—Silver Soldering.

CHAPTER VII.—CARBON BURNING AND OTHER USES OF OXYGEN AND ACETYLENE.
Principle of Carbon Burning—Method of Operation—Lead Burning—Soldering—Case Hardening—Heating Uses.

CHAPTER VIII.—HOW TO FIGURE COST OF WELDING.
Oxygen Consumption—Dissolved Acetylene Consumption—Torch Consumption Test—Acetylene Generator Consumption—Cost Card—Conclusion.

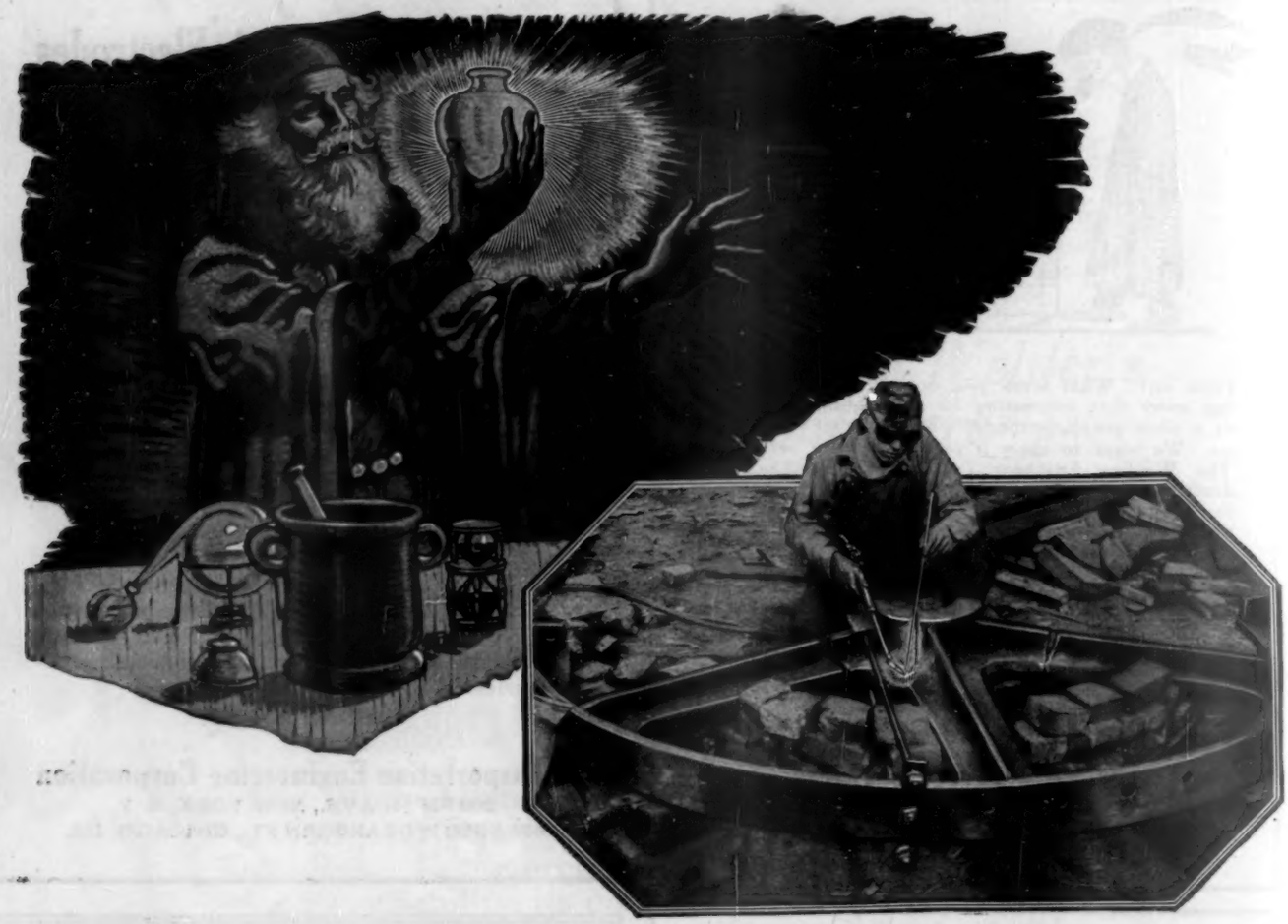
Sent to any address Postpaid on receipt of $1.50 **THE WELDING ENGINEER** 608 So. Dearborn St. CHICAGO ILLINOIS

MECO

MULTI-SEAT REGULATORS have four seats instead of one, but cost no more.

Write for prices and start to reduce your costs — NOW.

Modern Engineering Company
23rd and Walnut Streets • • St. Louis, U. S. A.



The age-old dream of the alchemist is realized because of Linde

THROUGH countless centuries man dreamed of transmuting the baser metals into gold. Patiently, laboriously, often consecrating their very lives to the work, the Alchemists of old toiled on toward their elusive goal.

As late as 1873 James Price, the last of the Alchemists, sought death by his own hand rather than acknowledge the failure of his experiments.

Linde Engineers of to-day have made this dream of by-gone ages come true.

By producing uniformly pure oxygen in industrial volume, they have made it possible for oxy-acetylene welders and cutters to reclaim thousands of tons of metal machinery annually—turning base metal into gold—a saving in money far in excess of any vision of wealth dreamed of by ancient philosophers.

And Linde does more than supply oxygen of absolutely uniform purity. Thanks to a chain of twenty-nine plants and forty-six warehouses it delivers Linde Oxygen when and where it is wanted in any volume.

THE LINDE AIR PRODUCTS COMPANY
Carbide and Carbon Building, 30 East 42nd Street, New York
Balfour Building, San Francisco

THE LARGEST PRODUCER OF OXYGEN IN THE WORLD

L-566-21

PROGRESS OF A. S. M. E. BOILER CODE

Report of Developments at Public Hearing of A. S. M. E. Boiler Code Committee Held at New York City, December 5, 1921

"THE preliminary reports on rules for the construction of unfired pressure vessels, which appeared in printed form, caused an unusual interest which was manifested by the many representatives present from various parts of the country at the open hearing before the Boiler Code Committee of the A. S. M. E., New York City, December 5th," says Mr. W. P. Kremer, of the Vilter Manufacturing Co., Milwaukee, Wis., in a recent letter to the American Welding Society, Chicago Section. Other committee work prevented Mr. Kremer from reporting this meeting before the Chicago Section of the American Welding Society, at its January meeting, as had been planned, so he communicated his observations to the Chicago Section by letter, an abstract of which follows:

"From the beginning, Mr. Fish, chairman, informed the audience that the printed code was only preliminary and was drawn for the purpose of this discussion, and to bring out the best practice.

"Many representatives present responded to the call for objections taken to the code, commenting in some instances on the rules, but generally taking exception to the restrictions. Very few, however, were able to refer to actual investigations, and consequently, the committee deemed it necessary to request such representatives to submit their views in detail in writing to the Boiler Code Committee of the A. S. M. E. at the earliest possible moment, not later than from 30 to 45 days from December 5, 1921. The replies requested will be of considerable value in formulating a proper and just code of rules and regulations.

"The committee at various times distinctly pointed out their desire to co-operate with all manufacturers of welded unfired pressure containers to the fullest extent.

"In view of the lengthy discussions at this hearing and the valuable work rendered by some of the larger manufacturers in the nature of experimental investigations, many other manufacturers' representatives expressed their willingness to make similar experimental investigations on containers with welded joints in the near future.

"Realizing the importance of such experimental work the committee decided to wait for their final draft of rules and regulations until such further experimental data has been submitted to them. Meanwhile the committee will develop a proper code to include rules and regulations based upon the evidence already at hand. It is, therefore, hoped that all manufacturers who have carefully read and considered the tentative code, submit in writing their viewpoints, suggestions and further recommendations as to the proper construction, design and operation of such containers at the earliest possible moment.

"By referring to the preliminary report, you will note the formula developed for arriving at the proper thickness or strength of metal for each class of containers as well as other details mentioned. Serious objections were taken by many of the members present, relative to the classification as outlined, because the classification was not just considering the many purposes for such containers and the service of such unfired pressure vessels as utilized in diversified industries. No provision was made to properly place welded pressure containers for instance, in the refrigerating industry.

"It was, therefore, decided to await suggestions from many manufacturers as to a more proper subdivision of classification of vessels which will more adequately fill the requirements considering the diversified service to which such containers are put. No definite plan of classification for vessels of this kind was arrived at during the public hearing, and this matter of classification of unfired pressure vessels is, therefore, open for further discussion.

"The ultimate strength of a joint which has been properly welded by the fusion method, that is, with the electric arc or by the gas process or for that matter with the forging process should be considered by the manufacturers and their experience serve them to recommend such joint efficiency in per cent, not too high, in order that safe vessels may be manufactured.

"The introduction of suitable safety appliances in connection with all unfired pressure vessels becomes imperative and essential and will be considered by the committee at length. These safety appliances will also have material bearing upon the acceptance of fusion welding for unfired pressure vessels in general as well as determine a more liberal attitude toward the adoption or elimination of many details now called for in the preliminary draft.

"The question of longitudinal welded seams in pressure vessels was thoroughly discussed, but no conclusions arrived at, it being left to the committee for further analysis when and where such longitudinal seams shall apply, whether of the single or double 'V' type and above what size the double 'V' welded longitudinal seam would be considered. Generally speaking the concensus of opinion at the public hearing believes for vessels less than 24-inch diameter the single 'V' welded longitudinal seams should apply, while for diameters larger than 24-inch double 'V' seams should be considered. It was also in evidence that the majority believes stronger seams would result in larger containers when so provided with double 'V' seams. Of course, the thickness of the material must be taken into account.

"Many forms of construction of circumferential welded seams were offered. Some forms provided for shrink-on rings, other crimped-over ends or circumferential seams without either one of the aforementioned additions. Naturally, outwardly dished heads, that is, heads concave to the pressure when so used require crimping over the ends. For dished in heads, that is, heads convex to the pressure, it has been found unnecessary to provide for additional strengthening by different forms of crimping for the reason that in extreme cases of pressure which might result in accident, the head will tend to bulge outwardly and create bending moments on such ends making it, therefore, impossible to tear the head out in the welded seam.

"The question of proper hydrostatic tests to which such containers shall be put before shipping same for installations was considered at length, but it was found that the preliminary draft covers fully what might be required, since practically all the manufacturers' test are in excess of the requirements.

"Referring to hammer tests of the joints on the metal immediately adjacent to the welded joints it has been the opinion that such tests are too severe and if exercised as specified would possibly weaken the joint rather than to give proof of the desired results. However, manufacturers are requested to give their viewpoints in this direction.

"The general hearing before the Code Committee has forcibly brought out the fact that the earlier criticism and objections taken on the part of the Boiler Code Committee of the A. S. M. E. against adoption or recognition of fusion

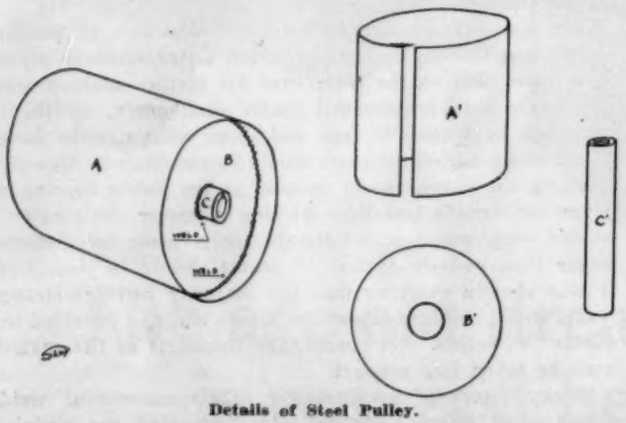
(Continued on page 54)

PINCH-HITTING WITH THE TORCH

Welder Gets His Customer's Plant Into Service by Making a Steel Pulley—Reduces Delay from Two Weeks to Five Hours

Dear Ed.:

I had rather a happy experience this morning; was calling on a man downtown and he asked me to go out to his plant. He said that perhaps I could give them some useful information and he knew that I would get a few pointers to make the trip worth while. I followed his advice and a short while later I was in the shop referred to and talking with Mr. Anderson, the superintendent. The minute I entered the shop, Ed, I knew there must be something in store for me. The whole plant seemed to have an air about it that stated just as plain as I'm writing here "we do things and do them right." Really, I've never been in a place that seemed to breathe efficiency in every corner like this one did. It was well lighted and its arrangement was wonderful, every machine in just the right place. I had quite a chat with Anderson, who possessed some rare ideas. There were any number of interesting things I'd like to tell you about, but most of them are a little out of your line. I learned that instead of being a manufacturing plant, in the sense of turning out a large number



Details of Steel Pulley.

of duplicate parts, that this institution was really a large job shop, catering to all the mines and sugar factories around the state. The unexpected breakdown is the thing that keeps their wheels turning and naturally the welding and cutting torches play an important factor in work of this kind. However, the welding is all done in a different building from the machine shops. While we were in the welding shop Anderson pointed out, among other things, a steel pulley that I thought might interest you, Ed.

"That's a mighty clever looking pulley," I said, "but I shouldn't think you could compete with the manufacturers along that line."

"You're perfectly right on that score, it does cost considerably more than a manufactured pulley, but we're not in the manufacturing business and it's only one of those emergency repair ideas that we have studied out," replied Anderson.

"I hope you'll pardon me if I don't see your side, but I feel sort of groggy today and I don't just see why, if you're going to do all that work, why you don't weld the old pulley that has broken instead."

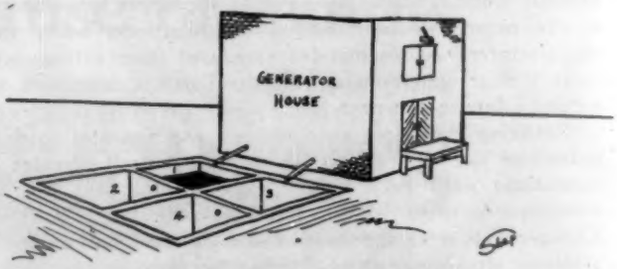
Anderson smiled and said, "Well, you know that circumstances sometimes alter the case and I see that I'll have to give you a little more light on this subject. If you'll just remember this one point you may see why we have to do most of our own thinking out here. Our state isn't very thickly populated and we're a long way from the source of supplies, so when a breakdown occurs, the main idea is to get it repaired and keep the plant in operation. The cost is usually of secondary importance."

"We had a typical call last Wednesday afternoon, just a week ago today, that will give you a good idea of what we have to contend with," he continued. "At four o'clock we received a long distance phone call from a mine about sixty miles from here. It seemed that the cast iron pulley on one of the main pumps had broken all to pieces and the mine was being flooded at the rate of one foot per hour. The size of this pulley was eighteen by twenty-two inches which evidently was an odd size. We were ordered to turn out a pulley in the shortest time possible, as time was the big factor in this case. At nine o'clock that evening the pulley was completed, just five hours after the order had been received, and one of our men rushed it out to the mine and the pump was again in operation at twelve that same night."

"Sounds almost too good to be true, doesn't it?" he asked, "but that's the kind of calls we get and we must always be on the watch to pick up helpful ideas. You can probably appreciate the predicament of this particular mine if you put yourself in its place for a moment and have a problem like this pulley confront you. With the water rising a foot an hour something must be done and done quick. Your pulley is not a standard size and if we were not on hand to give service only two other means of relief would be in sight. You could have a local shop turn out a pattern, wait for a foundry to cast one, and then have it machined or else you could telegraph to the manufacturer in the east and have a new one shipped by express. In the first instance, three or possibly four days would be necessary, whereas in the second probably a week or ten days would be required."

"I can plainly see where it would take all of that," I said.

"Well, if you were in their position you would certainly be glad to know that there was one institution always ready to serve and make an 'A number one' job of everything undertaken." Anderson continued. "This pulley, for example, that we turned out was light; had not the internal strains usually found in cast



Taking Care of the Residue.

pulleys and it was practically indestructible so it could easily be considered a permanent repair. Aside from this we turned out a job in five hours that would have taken days by any other method."

"It makes an awfully good looking job," I stated, looking at the one in the shop. "Is there any special way or method you use in putting it together?"

"Why no," he answered, "it's quite a simple thing after you get the idea. First of all we cut the rim out of flat plate, either wrought iron or mild steel. On small pulleys we use three-sixteenths plate but on the larger ones it's quarter inch. A little surplus is left on the sides so it may be dressed off when machined but the length of the piece cut out is very particular and must be exactly the same as the circumference of the pulley. This measurement can easily be found by multiplying the diameter by 3.1416. When this rim piece is cut to size it is next passed through a set of rollers and rolled until the ends just meet. The

two ends of this piece are then welded together and the rim is all ready for the next step."

"After the rim comes the web, or if the pulley has a fairly wide face or is subject to much strain, two or more webs will be required. Let us assume that our pulley has about a twenty or twenty-two inch face. We will need two webs so we cut them out of the same thickness of plate as used in the rim. This is done with a cutting torch and a compass attachment. A hole is also cut in the center of these webs or discs as they might be called to accommodate the hollow shafting which is to be used as the hub. The webs are then welded in position which should be about four inches from each side of the rim. A little fillet weld is all that is necessary and the same is applied to the shaft which forms the hub when it is placed in position. The only thing left to do now is the machine work. By boring out the hub to the correct size; taking a slight cut off the face, and bringing up the edges, we have a pulley that is not only ready for use but one which will not crack when dropped, and taken all in all, has many superior points to a cast pulley. But, as you have said, it would never do for a manufactured product on account of its cost. Its real service is in the case of an emergency as you can plainly see."

Now Ed, I don't know whether this description as I've jotted it down is clear enough or not so I guess I'll have to get my pencil out and draw you a little diagram. Between the letter and the sketch you ought to be able to dope out the idea and no doubt you can use it to advantage sometime, or it may bring to your mind some other application for the torch.

Another thing that seemed rather novel around this plant was the manner in which the acetylene gas is handled. Two generators are used and these are housed in a separate building by themselves. These generators are each of the two hundred pound type and are so arranged that they can be worked separately or together. When filling this kind of a generator with carbide it is customary to do so with the aid of a ladder on account of the height of the filler opening. At best this is a mean slow job and nobody ever enjoys it. In this case, however, another floor had been built just over the two machines and the cans of carbide are stored up there. A large funnel shaped hopper of galvanized iron has been built in the floor over each generator and it opens directly over the filler opening. When recharging is necessary a man can go up above the machines, where he has something solid to stand on and can empty a can or two of carbide in the hopper and fill his generator in short order.

So much for the filling, Ed, but what really caught my eye was the method of taking care of the residue. A large vat of concrete had been constructed behind the generator house. This vat is probably six feet deep; measures around twelve feet wide and fourteen feet long, and is divided into four different parts. Now when the generator is to be recharged and filled with fresh water the sludge valve on the generator is opened first and the used water allowed to discharge into the compartment in the vat nearest to it. After each discharge, the residue or sludge settles to the bottom and the water floats to the top. When one compartment fills up, the water flows into the next and gradually disappears due to evaporation or leakage, leaving slacked lime which is then dug out and used for various purposes, principally for building and fertilizing. No doubt you too will smile just as I did when learning that this carbide sludge was used in place of mortar but Anderson marched me over and showed me a one story brick building over a hundred feet long built with the residue from this vat as mortar and nothing else; seeing is believing, so there you are.

I'd like to jot down a few more things I saw today but methinks if I am to dash off that sketch I promised you of the pulley and perhaps toss in another to give you an idea how that sludge vat was arranged that we can ring off for this time. As a matter of fact, Ed, that salt water I surrounded when out at Saltair with friend George hasn't entirely left me yet, and I'm feeling far from a well man. Within the next few days I'll be leaving for Portland and if I run up against anything of interest you may depend upon me to shoot it along.

George wants to be remembered and says he'll see you either in church or jail.

Yours,

Shep.

LARGE TRANSFORMER CASE REPAIRED BY WELDING

The mid-continent oil fields have presented some of the most interesting welding problems that have confronted the industry since war days. A repair accomplished recently by the Dubler Welding Co., of Tulsa, Okla., while not so heavy a job as some that are handled from time to time in this district, is nevertheless sufficiently unusual to merit detailed description.

Both the base and the top of a General Electric transformer case, in service at the Tulsa plant of the Public Service Co. of Oklahoma, were very badly cracked, rendering the equipment useless until the parts were either repaired or replaced. It was decided that economy, both in time and cost, would be effected by employing oxy-acetylene welding in event that such a repair were practicable. The case, being 14 feet high and 4 feet in diameter and weighing approximately 1,400 pounds, unwieldly at best, was rendered especially so from a welding point of view because of the location and character of the break in the base, on which it was necessary to do vertical welding. Moreover, the drum, or body of the case, was of steel, while the base, to which it was thoroughly bonded, was of cast iron, thereby complicating the problem of expansion and contraction.

The fracture in the base, a casting ⅞ inch in thickness, started at a point near the center, extending to and through a four-inch flange at the periphery. There was also a transverse crack near the center, producing the effect of a cross. The opening at the flange was fully two inches wide, indicating that the casting had been subject to intense internal strain probably from the time it left the moulding flask in the foundry. The top, also cast iron,

Good Welding on a Transformer Case.

was cracked almost straight across the center from edge to edge.

No unusual difficulties were encountered in welding the top, owing to the fact that it was easily removed and could be handled in the ordinary way. It was quite different, however, with the base, which, as stated, was securely bonded to the steel shell of the case. Owing to the length of the drum, the case had to be laid on its side throughout the entire operation, thus rendering the work more difficult of access and of execution.

In preparing the base for welding, the edges of the breaks were beveled to an angle of 45 degrees with a cutting torch instead of with the cold chisel or air-chisel, as was formerly necessary in all chamfering operations on cast iron. The preheating was done by directing large gas flames on the entire lower end of the case and gradually elevating the temperature through a period of seven hours. The actual welding was done by Mr. Dubler, senior, and his son, and occupied about four hours, during which time fully 30 pounds of filler rods were deposited. The base was then allowed to cool very slowly, after which the weld was subjected to the usual water tests for leaks. It was

(Continued on page 40)

INCREASING WELDING SPEED*

Speed of Electric Arc Welding Can Be Increased by Increasing Electrode Diameter and Coating Electrodes

By H. R. Pennington†

ONE OF the most important questions facing the advocates of fusion welding is that of finding methods of increasing the speed of arc welding. The possibilities in this direction will be pointed out in this paper, and it is hoped that this introduction of the subject will result in some constructive discussion.

Welding speed on a given section is fundamentally dependent upon the rate of metal deposition and the amount of metal required to effect the jointure.

The first factor—rate of metal deposition—varies with the energy required to liquify the electrode material, arc stability, current density, etc. The amount of metal which must be applied obviously depends upon the type of joint and opening necessary to effect fusion between the edges or members to be joined.

The size electrode and arc current value that can be used, seem to be limited only by the thermal capacity of the base metal or joint. That is, the heat or arc current and electrode diameter can be increased until the molten metal of the weld area becomes difficult to control, or until the effects of expansion and contraction becomes an obstacle, and both these are governed largely by the thermal capacity of the joint.

One of the principle obstacles encountered in the past on attempting to use large diameter electrodes, was the poor welding qualities of such materials. With ordinary large diameter bare electrodes, a violent sputtering arc throwing out metal in all directions is a common occurrence at arc current values exceeding 300 amperes, and at 300 amperes the disturbances render the arc control very difficult and extremely uncomfortable.

No doubt one reason for this is the fact that the beneficial effect to the welding characteristic incident to drawing of electrodes in wire form are not present to the same extent in large diameter electrodes or what would commonly be classed as rods. These disturbances and poor welding characteristics of large electrodes generally resulted in inadequate penetration and non-uniform fusion.

If the electrodes are coated, a quite stable arc will be secured, permitting welding with metallic arc up to 500 amperes, with adequate penetration, uniform fusion and with a considerably lower electrode current density than that required for bare wire.

As a working basis for comparison, the rate of deposition for the usual size bare electrode and that of ¼-inch coated, both of mild steel grade on ½-inch plate wire were determined with the following results:

Elec Dia.	Arc Amps.	Lbs. Elec. Consumed Per Hour	Ft. Per Hr. Single Fillet Lap Weld.	Lbs. of Elec. Per Ft. of Fillet	Elec. Current Density
5/32 in. bare	150	2.3	6.8	0.33	7850
¼ in. bare	300	7.7	10.4	0.74	6220
¼ in. coated	300	8.09	18.6	0.43	6220

It will be noted that the increased speed of ¼-inch bare over 5/32-inch bare is not in proportion to the increased arc current. The increased pounds of electrode material per foot of fillet is due to the excessive amount of metal loss in passing through the arc.

The lower speed and rate of deposition of the ¼-inch bare as compared to ¼-inch coated is due to the difficulty of controlling a high current arc when using bare electrodes. Despite the greater amount of metal deposited, high current welding resulted in over a 100 per cent increase speed of welding of a single fillet lap joint.

These figures were obtained under ideal conditions and could not be equaled in commercial practice, as further tests have proven. However, the relative speed between small diameter bare electrodes and large ¼-inch coated electrodes with high arc current will remain practically the same. An additional factor to consider in using large electrodes is the fact that the time required to consume a large electrode is greater than that for a small one and therefore the percentage of welding time is actually increased. This load cycle should be given consideration when determining the capacity and basis of ratings of welding units for large electrode welding.

Experiments with high currents and large electrodes with exceptional penetration qualities, indicate that the speed of but welding can be increased by 100 per cent over present practice, especially since by using deep penetration electrodes the amount of scarfing necessary would be greatly reduced, if not eliminated, on plate thicknesses up to ⅜ inch. A reduction in the amount of scarfing is also desirable where high arc currents are used, in order to increase the thermal capacity of the joint.

The lap joint offers greater advantages, however, for large electrode welding than the butt joint, as the lap joint possesses inherently the requisite high thermal capacity and therefore permits a high energy concentration with an attendant high rate of fusion and deposition. In addition, lap joints with double fillet will permit of 100 per cent weld strength being secured without difficult.

A recent check on pounds of metal consumed per hour, using ¼-inch mild steel coated electrodes with 240 amp. arc current, showed the rate of deposition to be 6 pounds per hour. These figures were obtained from actual shop practice on locomotive frame welding and include time for considerable cleaning necessitated by applying successive layers in a vertical position.

From the foregoing it is clear that the limit of speed and rate of metal deposition has by no means been attained in present day practice, but in order to permit the use of higher arc currents, the electrical resistance of the electrodes must be decreased by an increase of electrode area. Otherwise, difficulty of arc control will be experienced, due to overheating of electrode.

Attention has been drawn to the possibilities in this direction in order that those contemplating the adoption or extension of arc welding may give consideraion to high arc current welding, which from present indications will be increased to at least 300 amperes for a great majority of the work now done, with arc current values not exceeding 200 amperes.

DISCUSSION

Mr. Kincaid:—It is evident enough that the cost of welding varies with the speed of welding particularly production welding and it is probable that 98 per cent of the electric welding equipment used today is used on production work. When metallic arc welding was first adopted commercially, it was thought that the limit would be reached with a 5/32 electrode diameter and 150 ampere current. The first time I saw the work done by Mr. Oliver at the Standard Oil Company, my theories were all upset by his successful use of a quarter inch electrode. Today, we are not prepared to answer the question—"What is the limit?" We have used a ¼ inch rod with 600 ampere current successfully. Mr. Pennington's point on coating is a very good one. Large

*Paper read before the American Welding Society, Chicago Section, Friday evening, December 2, 1921, 8:00 P. M., in the rooms of the Western Society of Engineers, Monadnock Building, Chicago.

†Supervisor of Electrical Equipment and Welding Chicago, Rock Island & Pacific Railroad; Vice-Chairman, Committee on Manganese Welding, American Welding Society.

rods will of course require coating. The work which I mentioned done with a ¾ inch rod was helped by a "home made" coating.

In tank work, the present tendency is toward automatic equipment.

When using a large covered electrode, it seems advisable to recommend the use of reverse polarity because in that way, a larger percentage of amperite can be retained. The coating makes possible a superior deposit and a better weld. It seems to be true that by using the same current and a larger electrode, more metal can be deposited per hour. A reasonable explanation for this would seem to be that with the same current and a larger electrode the thermal efficiency of the arc is greater. The crater has a parabolic form and the heat radiating from the focal point toward the end of the electrode is used to greater advantage when it has a larger surface to strike.

Of course, in some places larger electrodes cannot be used, i. e., on thin sheet metal, but it would be possible to use a larger electrode on many other jobs which are being done today.

Mr. Oliver:—I am much interested in the paper Mr. Pennington has read in regard to the speeding up of welding by using large diameter electrodes. We have been using the ¼-in. electrodes with 200 ampere machines at our Whiting Works for six years due to the increased production obtained.

The advantage of the ¼-in. Electrode is particularly noticeable in the caulking of our riveted seams on stills having a plate thickness of ½-in. 5/8-in. and ¾-in. Our experience shows that 10 feet of weld per hour can be made with ¼-in. bare Electrode as compared with 8 feet per hour for 5/32-in. bare Electrodes, and 7 feet per hour for 3/16-in. bare electrodes. The average current used for each size is as follows: Note: This applies to overhead, vertical and straight flat seams combined—

Based on Bare Electrodes.
¼-in. 180 to 200 Amps.
5/32-in. 170 to 180 Amps.
3/16-in. 150 to 160 Amps.

We have recently made some tests with 3/16-in. and ¼-in. Bare and Coated Electrodes to determine the amount of metal deposited per hour, metal deposited per K. W. H. and the metal lost per pound deposited. A brief summary of the results of this test might be of interest.

The Electrical Power was measured by an Esterline curve-drawing wattmeter. One interesting fact brought out was the power consumption of 3/16-in. and ¼-in. Electrodes is practically the same even though more metal is deposited by the ¼-in. in a given time. This is shown by the following table.

	Ounces Deposited Per KWH		Per Min.	
	3/16-in.	¼-in.	3/16-in.	¼-in.
3/16-in. Bare Iron	5.38	6.62	.411	.826
3/16-in. Coated Iron	6.52	6.47	.500	.758
3/16-in. Coated Mild Steel	9.09	8.65	.600	1.010

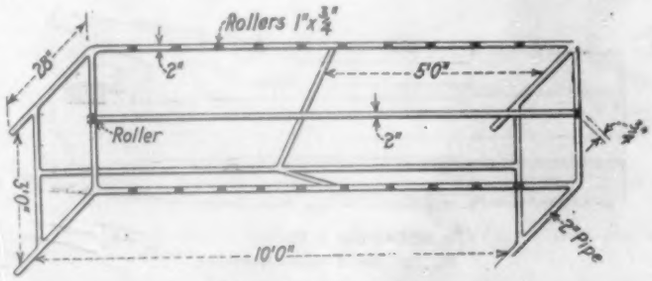
These results show the advantage of using the larger sizes of Electrodes whenever possible. There is a limit to the size that can be used on any particular job. This limit, as Mr. Pennington says, is determined by the heat capacity of the parts to be welded. The effect of expansion and contraction due to the increased heat of the larger sizes should also be considered. It is my idea to use the largest sized electrode which is possible to use without over-heating the weld.

TABLE FOR OXY-ACETYLENE CUTTING

By J. J. Albert

Repair Track Foreman, Michigan Central, Kensington, Ill.

An effective form of table for holding sheet metals while being cut with a torch is shown in the illustration, the idea being to have the plates brought to the operator on rollers with no undue exertion on his part and enabling him to stand in one place. The table is built of two-inch pipe, twenty-two—1-in. by ¾-in. rollers being used to carry the work to the operator. These rollers extend ½ in. above the surface of the table, being applied on pins cut and welded into the pipe. This arrangement leaves the rollers free to revolve and by having



Details of Cutting Table.

the table center brace ½ in. below the surface of the table the material will not drag if it sags down but will bear on the rollers only. The value of this table as described lies in the fact that it can be quickly and cheaply constructed, at the same time assisting materially in the work of oxy-acetylene operators when cutting all kinds of sheet metal.—*Railway Mechanical Engineer.*

TEST OF WELDING WIRE TO DETERMINE ADVANTAGES OF COATED WIRE

	Test No. 1—3/16-in. Wire			Test No. 2—¼-in. Wire			Test No. 3
	Bare	Coated No. 1	Coated No. 6	Bare	Coated No. 1	Coated No. 2	Coated No. 1
Weight of plates before welding	127.5 oz.	125.0 oz.	128.0 oz.	131.5 oz.	128.0 oz.	130.0 oz.	46.5 oz.
Weight of plates after welding	131.0 oz.	129.5 oz.	135.0 oz.	136.0 oz.	133.5 oz.	134.5 oz.	48.5 oz.
Gain in weight of plates	3.5 oz.	4.5 oz.	7.0 oz.	4.5 oz.	5.5 oz.	4.5 oz.	2.0 oz.
Weight of wire before welding	7.5 oz.	13.5 oz.	11.0 oz.	18.5 oz.	19.0 oz.	19.0 oz.	6.0 oz.
Weight of wire after welding	0.0 oz	6.5 oz.	2.5 oz.	9.5 oz.	9.5 oz.	9.5 oz.	3.5 oz.
Weight of stub ends after welding	2.5 oz.	2.5 oz.	1.5 oz.	3.5 oz.	3.5 oz.	5.0 oz.	.5 oz.
Weight of wire used	5.0 oz.	4.5 oz.	7 oz.	6.0 oz.	6.0 oz.	4.5 oz.	2.0 oz.
Weight of wire deposited	3.5 oz.	4.5 oz.	7 oz.	4.5 oz.	5.5 oz.	4.5 oz.	2.0 oz.
Weight of wire lost in arc	1.5 oz.	0 oz.	0 oz.	1.5 oz.	.5 oz.	0 oz.	0 oz.
Time of Test	8.52 min.	9.00 min.	10.28 min.	5.45 min.	7.25 min.	4.45 min.	3.42 min.
KW average	4.6	4.6	4.5	7.5	7.0	7.0	4.6
KWH used	.65	.69	.77	.68	.85	.52	.26
Oz. deposited per KWH	5.38	6.52	9.09	6.62	6.47	8.65	7.69
Oz. deposited per Min.	.411	.5	.68	.826	.758	1.01	.584
Loss per pound Deposited	.429	.0	.0	.33	.09	.0	.0
KWH per pound Deposited	2.97	2.45	1.76	2.41	2.47	1.85	2.08

Date—September 7, 1921.
Observers—F. D. Rexwinkle, A. Oliver.
Operator—P. Martin.
Electrician—G. Locke.

LOCOMOTIVE BOILER WELDING*

Special Committee of Master Boiler Makers' Association Reports Best Methods of Reconditioning Boilers

THE responsibilities of good welding depend largely upon the skill and experience of the operator.

Welding electrodes that have the approved chemical contents or elements which will give the best tensile strength which conditions may require should be adopted for boiler repairs. Another important point is that welding electrodes which are to be used on firebox welding should have even

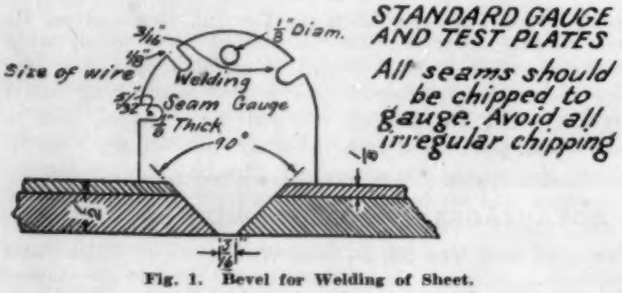

STANDARD GAUGE AND TEST PLATES
All seams should be chipped to gauge. Avoid all irregular chipping
Size of wire
Welding Seam Gauge
Thick
90°

Fig. 1. Bevel for Welding of Sheet.

flowing qualities; that is, the globules of metal should flow from the point of the electrodes to the work in a steady stream, so they will not interfere with the skill of the operator or the functions of the electric arc. The efficiency of the operator should be fully determined before he is allowed to perform any welding in locomotive fireboxes, by having him

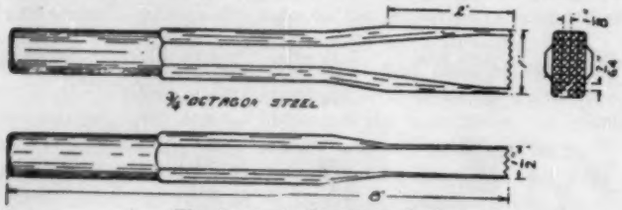


Fig. 2. Scale Removing Tool.

weld specimens at least once each month. The welded specimens should be forwarded to the engineer of tests who will test them for tensile strength. The efficiency of the welded specimen should be at least 75 percent of the firebox steel used, before the operator is allowed to do any firebox welding.

It is important that good judgment should be exercised in assigning operators to autogenous welding in fireboxes.

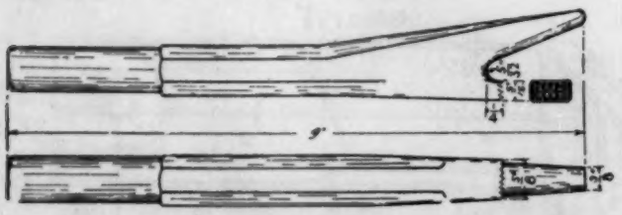


Fig. 3. Bead Scale Remover.

Another important feature is that no piece of work should be welded unless it is properly prepared. That is, all seams should be beveled as in Fig. 1, and should be thoroughly cleaned, free from grease, rust, scale and other foreign substances. It is very essential that the weld be made on bright clean metal and that this condition be preserved throughout the entire welding operation. The use of a roughing tool as shown in Figs. 2 and 3, or a sand-blast machine, may be used for cleaning purposes. All seams should be carefully fitted and beveled to 45 degrees, not allowing more than ¼ inch or less than ⅛ inch space at the bottom of the V as shown in Fig. 1, as determined by the use of a gage.

If the opening at the bottom of the V closes to less than ⅛ inch, the welder should stop and have it chipped to the standard opening. Under no condition should the plate be burned with the cutting torch to enlarge the opening, unless it is going to be chipped afterward.

The tables give an approximate comparison of the cost

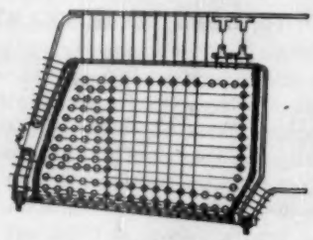


Fig. 4. How the Firebox is Welded.

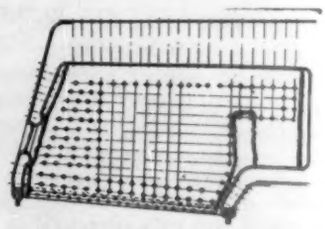


Fig. 5. Firebox and Combustion Chamber Welded.

of labor between applying an electric welded three piece Mikado firebox and riveted box of same type.

For a riveted firebox, the operation is approximately the same as in Table 1 after eliminating the welding and adding the items in Table 2.

Welding of Complete Fireboxes

All sheets should be beveled on the rivet line from the fire side, Fig. 4, and plates should be fitted into the mud ring, held together with strongbacks or clamps about every 1-

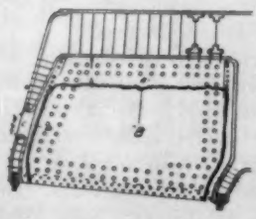


Fig. 6. The Knuckle-patch in the Firebox.

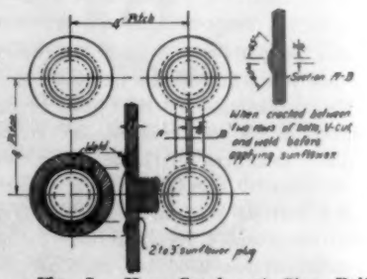

Pitch
Section A-B
When cracked between two rows of bolts, V-cut and weld before applying sunflower
Weld
2 to 3 sunflower plug

Fig. 7. How Cracks at Stay Bolt Holes Are Welded.

inches in order to hold the plates in perfect line. The sheet should then be tack welded between each of the clamps, the tacks being from two to three inches wide. After this operation has been performed, the clamps should be removed and the intermediate spaces welded. Do not remove the firebox from the ring until after the welding has been completed. All seams should be reinforced 20 percent of the thickness of the firebox sheet on the fire side and when it is possible to do so, seams should be reinforced on the water side approximately 10 percent, especially on the crown sheet.

All welding should be started at the bottom of each intermediate space and finished at the top of the seam. For all firebox work current values from 100 to 125 amperes will

*This report will be presented at the Master Boilers Makers' Association Convention, which will be held at the Hotel Sherman, Chicago, May 23 to 26, 1922. The report committee consisted of H. H. Service, supervisor of welding, Atchison, Topeka and Santa Fe Railway, Topeka, Kansas, chairman; I. J. Pool and R. W. Clark.

give the best results when properly handled by the operator using a 5/32-inch diameter electrode. The cost of welding firebox seams per lineal foot is 90 cents for labor, material and current.

Preparing Half Side and Door Sheet for Welding

The sheet should be bolted to the mud ring after it has been properly beveled and fitted in place. Staybolts may be applied, except the rows adjacent to the seam which is to be welded. All horizontal seams should be held in place with strut bolts and tack welded every 12 or 14 inches. Then weld intermediate spaces alternating from the center space to the

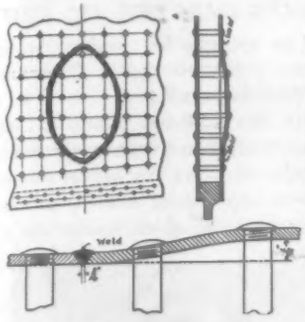


Fig. 8. Patching Around Defective Staybolts.

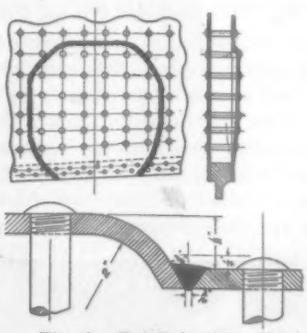


Fig. 9. Patch in Side Sheet.

spaces at either end. Vertical seams should be tack welded similar to horizontal seams. After being tacked, start welding at the bottom space and finish at the top space. Current values for successful welding on this operation are the same as for firebox welding described in Fig. 4 and Fig. 5.

Firebox Sheet Knuckle Patch

Preparation for the firebox knuckle patch, Fig. 6, may be followed as outlined for the welding of half side sheets or

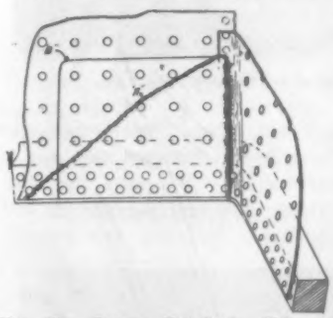


Fig. 10. Corner Patch in Side Sheets.

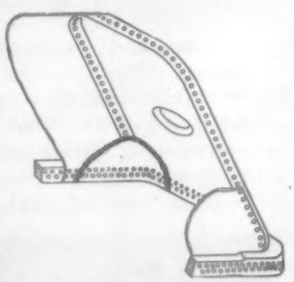


Fig. 11. Patch at Junction of Side and Door Sheet.

door sheets. The use of strut bolts can be applied to hold the patch in line when necessary, while it is being tack welded. All strut bolts should be removed after the patch is welded into position. Under no circumstances should the

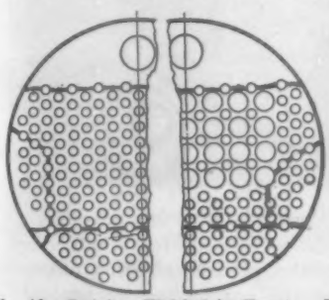


Fig. 12. Patches Welded in Front and Back Flue Sheets.

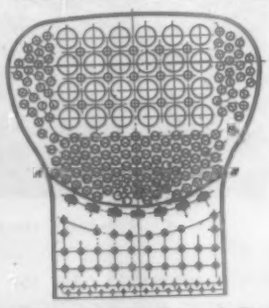


Fig. 13. Top Portion of Back Flue Sheet as Arranged New for Superheater.

knuckle patch be less than 12 inches from the crown sheet.

Weld the horizontal seam first, then tack weld the flanged sheet to the wrapper sheet. Remove all strut bolts and weld intermediate spaces, working from the bottom on either side of the patch upward, finishing at the top.

The method indicated in Fig. 7 is to be used to repair cracks at staybolt holes in firebox sheets, where not more than 6 sunflowers are necessary to complete repairs, and not more than 4 sunflowers will be joined together. This system may be used in main shop general repairs, sunflowers not to exceed 3 inches in diameter.

Repairing Small Portions of Side Sheet

When the defective portion does not extend over six staybolts repairs can be made as per instructions given for Fig. 7, which give very efficient results. When the defective portion is larger it is then advisable to use methods as shown in Fig. 8, by removing the defective portion and applying a patch of an elliptical or circular shape. In preparing the patch, sufficient metal should be allowed so that when the patch is dished 3/8 to 1/2 inch in the center, the opening at the

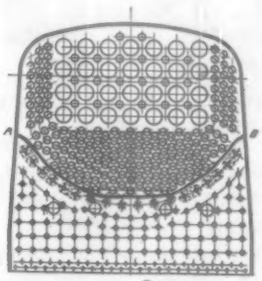


Fig. 14. New Top Portion With Wide Firebox, Back Flue Sheet.

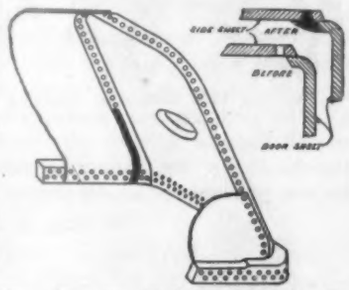


Fig. 15. Method of Welding Defective Seams.

seam should not be more than 1/4 inch wide at the bottom of the V and not less than 1/8 inch. The patch should be held in place by strut bolts and tack welded on the right or left side; then weld this seam of the patch before the opposite

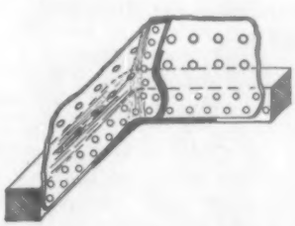


Fig. 16. Repair to a Leaky Mud Ring Corner.

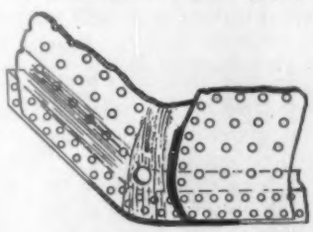


Fig. 16A. Another Section of the Mud Ring.

side is tack welded, so as to allow the patch to draw in one direction. After this has been completed, allow it to cool before starting on the opposite side. By so doing there will be only one contraction of the patch. All welding should be

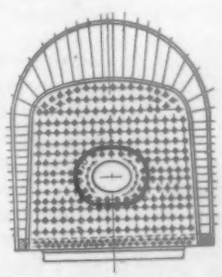


Fig. 17. Patch Welded on Door Collar.

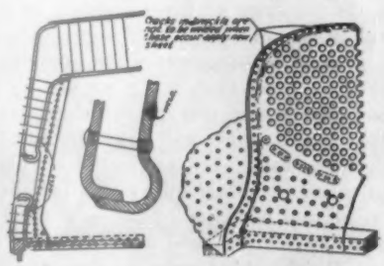


Fig. 18. Knuckle Cracks Not to Be Welded.

performed from the bottom upward. Should the defective portion of the side sheet extend down to the mud ring rivets, apply the patch as in Fig. 9, the welding operation being the same as outlined for Fig. 8. Should the defective portion be at a location as shown in Fig. 10, the seam may be applied as indicated by line "A."

Should the plate at the corner of a firebox become defective and it is necessary to remove a portion of the side sheet and the door sheet, it is advisable to apply a patch to both sheets as in Fig. 11.

Should it be necessary to make repairs according to Fig. 12, Fig. 13 and Fig. 14, the work should be done by welding from the fire side of the sheets and reinforcing them on the water side.

Method of Welding Patch on Front of Crown Sheet

Should it be necessary to repair the front portion of the crown sheet, prepare for welding as outlined previously. A very important feature about this welded seam is that the front point adjacent to the flue sheet should be finished on

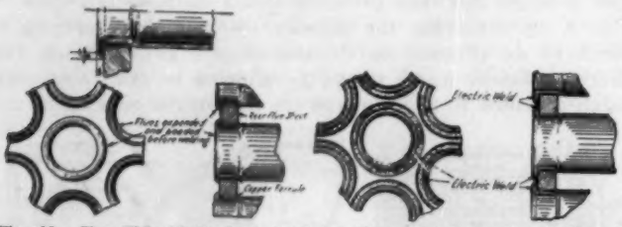


Fig. 19. Use This Method of Applying Flues in Locomotive Boilers by Means of the Electric Arc Welding Process.

the flat side of the firebox at least 12 to 14 inches below the highest point of the crown sheet.

Welding of Seams

Should the seams become defective and cause considerable trouble, repairs can be made with the electric arc process as shown in Figs. 15 and 16.

Remove the defective portion of the flange, which is giving trouble, by cutting through the back of the rivet holes, bevel the sheet 45 degrees and tack weld it every 12 inches; then weld the intermediate spaces. The weld should not be any thicker than the flange of the sheet and tapered to a point. Weld the old rivet hole solid as shown in the illustration.

Broken Mud Ring

In case mud rings become broken it is advisable to remove a portion of the firebox sheet. Bevel the mud ring from the top, giving at least ¼-inch opening at the bottom of the V, and reinforce it at the bottom of the mud ring after the weld has been completed on the top portion, afterward applying a patch on the portion of the firebox which was removed. The welding current values for welding mud rings are from 125 to 150 amperes, using an electrode 5/32 inch in diameter.

Should the door collar become defective, the defective portion can be removed and a patch applied as in Fig. 17, following the instructions as described for Fig. 8.

Improper Welding of Firebox Plates

Under no circumstances should welding be allowed directly in the knuckles of firebox sheets as shown on Fig. 18. This ruling should be enforced vigorously.

It is very important when applying copper flue ferrules to the flue sheet that, when set and rolled, they do not project out on the fire side of the sheet, so that when the flue is applied the copper will not project under the flue beads. After the flues have been set in the regular manner very good results may be obtained by welding them after having received the second working. That is, if the locomotive is allowed to work its regular turn until the flues are to be reworked the second time, this allows the flues and flue sheets to get a good setting. By so doing it also allows the grease to be burned off the sheet.

After the flues are worked the second time, the sheets should be thoroughly sand blasted. When welding, the top row of flues should be welded first, the second row next and so on until the entire flue sheet has all the flues welded to it. It is very essential that the welding should be started at the bottom of the flue and worked upward, the weld being finished at the top of the flue to secure satisfactory results. It is in this operation that the flowing quality of the electrode is most important and should be given a great deal of consideration. The heat values on this operation vary widely and the operators should use their best judgment according to conditions.

Care should also be exercised on the part of the operator not to apply an excessive amount of metal. If he should do so, the metal will overheat and crack and cause a great deal of trouble. If it should become necessary to reweld a leaky flue which has been welded previously, all the old metal or weld should be removed and the flue worked tight into the sheet, after which it should be sand blasted and welded as formerly described.

WELDING ENGINEER SAVES SMELTER BIG SUM

A long time ago someone with an aptitude for making phrases coined the saying, "It's easy when you know how." Of course it isn't always easy, but knowing how helps a lot.

Some time ago the Bunker Hill and Sullivan Mining & Concentrating Company of Kellogg, Idaho, had twenty-six 8-ton cast iron melting pots that had been so badly cracked in service at its smelter that they had either to be scrapped or some method of reclaiming them found. They represented an investment of

Welding Was Accomplished by Correct Preheating.

$31,200. Their value as scrap would be less than a tenth that amount, from which would have to be deducted the cost of transportation to market and reduction. Naturally the alternative of reclamation was important. The first experiments with gas welding resulted disappointingly, but the oxy-acetylene

Fire-brick Oven Used for Preheating.

process seemed to offer the greater promise of being ultimately successful, and for this reason the engineering department of one of the large apparatus manufacturers was given an opportunity to work out the problem.

In its every-day applications welding is a comparatively simple operation, in which ordinary skill and judgment are sufficient to successfully perform the work. In extraordinary applications, such as the reclamation of these ponderous pots, it is something more—it becomes an engineering problem for which

practical experience and ordinary judgment are not enough. There must be an understanding of the fundamentals of the particular problem and a knowledge of how to work out the best way of dealing with the usual situation. The engineer in this instance was equal to the emergency. He not only successfully welded several of the pots, which have now been some time restored to service, but conducted the demonstration so that other operators could proceed with the reclamation of the remaining pots. The officials of the Bunker Hill and Sullivan Mining & Concentrating Co. were so satisfied with the results obtained that they at once ordered a complete installation of the equipment used, including generators for acetylene, and in future it will be used on work of this kind and for general welding and cutting at the mine and smelter in making repairs to broken and worn machinery and plant structures.

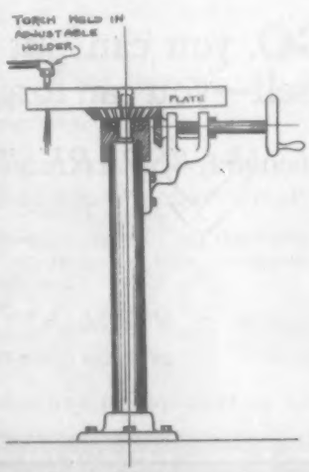
It should not be concluded, however, that the oxy-acetylene service engineer accomplished his demonstration without some pioneering to develop the best method of procedure. For example, when he tried to preheat the first pot in an improvised charcoal furnace, he discovered that twenty-six sacks of charcoal burning at one time around the pot little more than warmed it. It was not until he supplemented this with a blast from an oil and compressed air line connected with a nearby power house, and covered the furnace and casting with asbestos paper, that he succeeded in securing the preheat necessary to procede with the welding. The pots had been subjected to such high temperatures in service that a large part of the carbon was burned out as in the grate bars of furnaces. This made it necessary to bring the pots to a high temperature before starting to weld in order to effect a homogeneous weld. Of course the pots were annealed after welding, to restore the original structure.

The welding demonstration described was conducted by one of the service engineers of the Oxweld Acetylene Co.'s Seattle branch. That missionary work of the kind is not wasted effort is evidenced not alone by the Bunker Hill and Sullivan's purchase of equipment, but, as well, in the fact that the Northport Smelter Co., in the same general district, hearing of the success of the work at Kellogg, Idaho, also ordered welding apparatus especially for the reclamation of melting pots.

MECHANICAL HELPS FOR THE TORCH

By B. Heyman

ALTHOUGH manufacturers of welding and cutting apparatus have developed a variety of machines for automatically performing operations, which were previously and in many cases are still being done by hand, it has been left almost entirely to individual initiative to design and perfect automatic or semi-automatic machines for a multitude of special duties. Probably the most outstanding machines are the oxy-graph and the tube welding machine, the former being used for cutting intricate shapes, and the latter, in its many forms, having been adapted to the welding of tubes, cylinders, magazines, special shapes, etc.



Still, there are numerous applications to which little or no attention has been given by the manufacturer of equipment, for the simple reason that he has no broad market for the machine which might be used for one specific operation, although to the indivdual manufacturer who needs such a machine, and who could obtain one, it would be a valuable asset.

In the manufacture of knitting machines, for example, there is required a great quantity of circular steel rings varying in thickness and in their inside and outside diameters. To machine these rings from the solid plate would be rather costly even if this were done by milling and turning operations. Rather than resort to this tedious process these rings are cut with an oxy-acetylene or oxy-hydrogen torch leaving sufficient stock for roughing and finishing lathe cuts.

Of course, the cutting could be done with a hand torch, but it is assuredly much more economical and accurate to control the torch in a machine. And such a machine has been developed and built for the knitting machine manufacturer. Not only is it of cheap construction, but it is durable. Furthermore it does the cutting most efficiently and accurately. The sketch shows the construction, which consists of a substantial base carrying a movable platform controlled in its rotation by two bevel gears. The torch is mounted on a movable holder so that any diameter can be cut without complicated adjustments or measurements.

This points out only one simple case where individual initiative has resulted in a method of economically producing the required product. There are any number of such examples of welding and cutting applications where the welding engineer can be of service to the manufacturer in turning out simple, cheap devices which will eliminate manual labor and turn out a less costly and better product.

Jigs and fixtures can best be designed and manufactured for welding and cutting operations under the supervision of the welding engineer. It is not simply a case of designing or drafting ability to turn out a tool which will be used in conjunction with the torch. Rather, it requires thorough understanding of expansion and contraction forces, heating requirements, and the many other little variables that must be considered in welding and cutting.

How important a part such knowledge plays can best be understood by considering a concrete case. A large telephone company found it necessary to shorten several hundred steel bars used in switchboard work. These bars were to be shortened by cutting out 1⅜ inches from the center and welding together the two pieces, which were then finished by milling the weld and plating the bar. The bar had a series of holes drilled through its entire length. One important requirement of the contract was that the distance between the two center holes be a specified distance after welding.

The welding concern which was to handle this work made a simple jig to align the work after the central part had been cut out with the torch. But the first few pieces which were welded indicated that the central distance could not be held to any specific amount. Upon consulting a welding expert a few changes were made in the form of the jig and the welders were instructed how to hold the expansion and contraction within a limited area so that the contract requirements could be kept.

How important a part the welding engineer can play in industrial lines has hardly been appreciated to date. Welders there are innumerable; also cutters. But the number of men, who have the requisite metallurgical and mechanical knowledge combined with practical welding and cutting experience, is somewhat limited and these are not utilized to their utmost possibility in the advancement of manufacturing processes. In this, the manufacturer is mainly to blame, as he fails to appreciate how he is handicapped without the welding engineer's aid, although the latter has been ready for service at all times during the past few years and has proven without doubt his ability to solve industrial problems and increase production.

THERMALENE IN NEW QUARTERS

Thermalene ga sproducers, the equipment as well as the supplies are now manufactured by the Triangle Mfg. Co., 314 W. 43rd St., Chicago. The basic process U. S. patents granted to Mr. Linus Wolf are owned and controlled by this company. Thermalene gas is a combination of combustible gases to be used in combination with oxygen or air.

WELDING AND CUTTING APPARATUS

MANY a weld takes all the skill in a man's fingers and all the brains in his head. When he is welding a broken aluminum crank case, for instance—what he wants to concentrate on is the heat-diffusion, alignment, temperature of his metal, the oxide, and so on—*the weld itself!*

He wants to *forget the torch*, as a sculptor forgets his chisel!

Before the REGO was perfected, this was impossible. Simply because, very often, the torch required nearly as much attention as the weld itself—to the detriment of the welding art.

Now you can forget the torch when you weld with a REGO.

The explanation: the REGO flame is made by oxygen and acetylene, mixed in the tip, under *low, balanced pressure.*

The REGO flame is neutral, smooth, steady—it will not flash back. Plunge the REGO tip into molten metal, press it tight against fire-brick—still it will not flash. The one torch for close quarters! It will not oxidize, carbonize, or blow the metal.

When you weld with a REGO, you can put your whole thought and skill on the weld itself—you can forget the torch.

Write for the REGO *booklet, "SPARKS"*

THE BASTIAN BLESSING COMPANY
WEST AUSTIN AVENUE AT LA SALLE STREET CHICAGO.

WELDING AND CUTTING APPARATUS

REGO "LITTLE SIX" OUTFIT FOR $57.50

Welding—Cutting—Brazing—Lead Burning—Radiator Soldering—Decarbonizing

REGO "Little Six" fills the demand for a small, complete, quality outfit for the garage or repair shop.

THIS is not a departure from the regular REGO line.

The "LITTLE SIX" OUTFIT is a special assortment of STANDARD REGO HIGH QUALITY EQUIPMENT.

Rego "Little Six" Outfit

1 REGO MT torch
3 one piece copper welding tips, Nos. 1, 3 and 5.
1 Cutting tip and tip nut.
1 Special lead welding and radiator tip.
1 Decarbonizing torch (separate and complete).
1 Single gauge oxygen regulator.
1 Single gauge acetylene regulator.
10 Ft. corrugated oxygen hose.
10 Ft. corrugated acetylene hose.
2 Wrenches.
1 Spark lighter.
1 Pair spectacles.
1 Instruction book (Dunham's Automobile Welding).
1 Carrying case.

The "LITTLE SIX" outfit is so called because the man who owns one can perform the six most important types of repair jobs, namely:

1. Welding up to 1 in. thickness.
2. Cutting up to 1 in. thickness.
3. Brazing.
4. Battery repair.
5. Radiator repair.
6. Decarbonizing.

This complete REGO QUALITY outfit with an instruction book that tells you how, all packed in a handy carrying case, is the little outfit you have been waiting for.

Order one now direct or send us the name of your jobber

THE BASTIAN BLESSING COMPANY
WEST AUSTIN AVENUE AT LA SALLE STREET CHICAGO.

OXY-ACETYLENE WELDING RODS*

Composition of Welding Rods for Different Classes of Work with Important Suggestions on Operation

By J. R. Dawson†

UNTIL very recent years little scientific welding research has been done and, although much has of late been accomplished towards improvement in welding rods and the welding art, there remains great opportunity for advancement, especially in the direction of the design of rods best suited to various requirements.

It has been my privilege to conduct in collaboration with my associates and to closely observe a considerable number of tests in connection with certain investigations of standard commercial welding rods, as well as of experimental rods of various compositions, and this paper is based on information thus obtained.

Due to the wide range of metals to which oxy-acetylene welding is applied, and to the high-grade welds that are being obtained, the process is gaining rapidly in volume of work done.

It may be used to join the edges of pieces where desirable physical properties are essential, the requirements depending upon the particular service conditions, such as resistance to shock, great tensile strength, or stiffness.

It may be used for building up worn surfaces, where hardness and ability to resist shocks are necessary in the weld metal, and for preparing locally hard surfaces through the use of alloy steel rods.

It may be used in the form of a bronze for brazing or in the form of solders of any required composition.

There are practically no metals in commercial use that cannot be successfully welded by the oxy-acetylene torch, if the proper filling metal and proper manipulation of rod and blowpipe are employed.

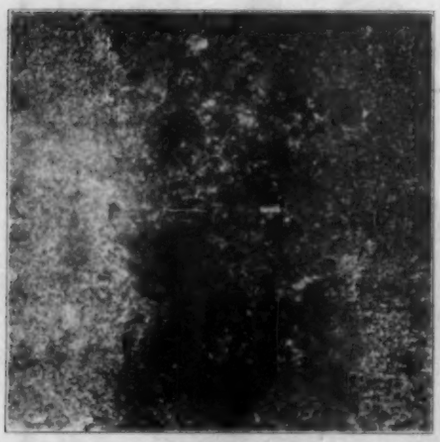


Fig. 1 shows filled in weld metal and its junction with the original steel plate. Humphrey's cupric chloride, etching reagent was used, and the weld metal was made the darker by this treatment.

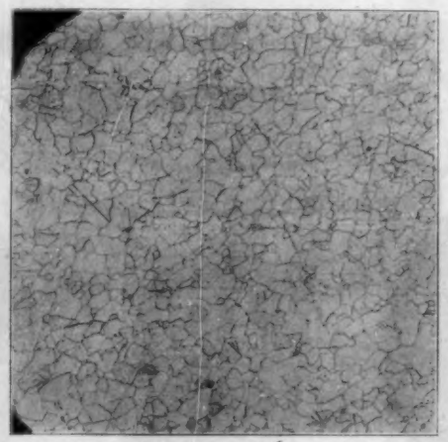


Fig. 2—This specimen contains less than 0.5 per cent carbon. The field is made up of ferrite and small inclusions of oxides which are frequently found in very soft steel.

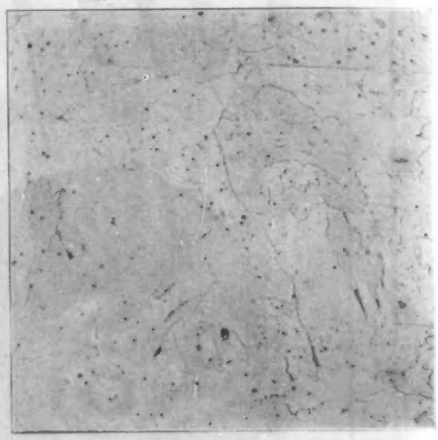


Fig. 3—Weld made from very low carbon rod, containing large irregular ferrite grains. The scattered black dots are iron oxide. This impurity is less frequently found in welds made from a slightly higher carbon rod.

The welding of aluminum, copper, brass and bronze is practically confined to this process and, on account of the strong, readily-machinable welds obtained, most cast iron welding also is done by this method. Where strength, combined with favorable ductility is required in steel welding, the oxy-acetylene process again stands forth as best able to supply high quality. It is felt that the development of this industry is still in its initial stage, and there is no question but that with every increase in the importance of the industry there is a corresponding increase in the importance of the tools the welder uses.

Function of the Welding Rod

Because of the wide range of applications of the oxy-acetylene process, it is clear that any discussion of the various rods used must necessarily be brief.

The function of a welding rod is to supply metal, that is added during the welding operation to form a part of the weld.

It may be used merely to fill in cavities, such as blow holes or other irregularities in castings, in which case it is desirable and usually necessary that the welding metal should have good machinable properties.

Great strides have been made in perfecting the apparatus used in this industry and in improving the quality of the gases and the facilities for their economical distribution. These higher quality welding materials enable the operator to obtain correct mixtures of the gases and to maintain a close control of the flame. This feature is important, because variations in the intensity of the flame or the use of incorrect gas mixtures lowers the quality of the weld.

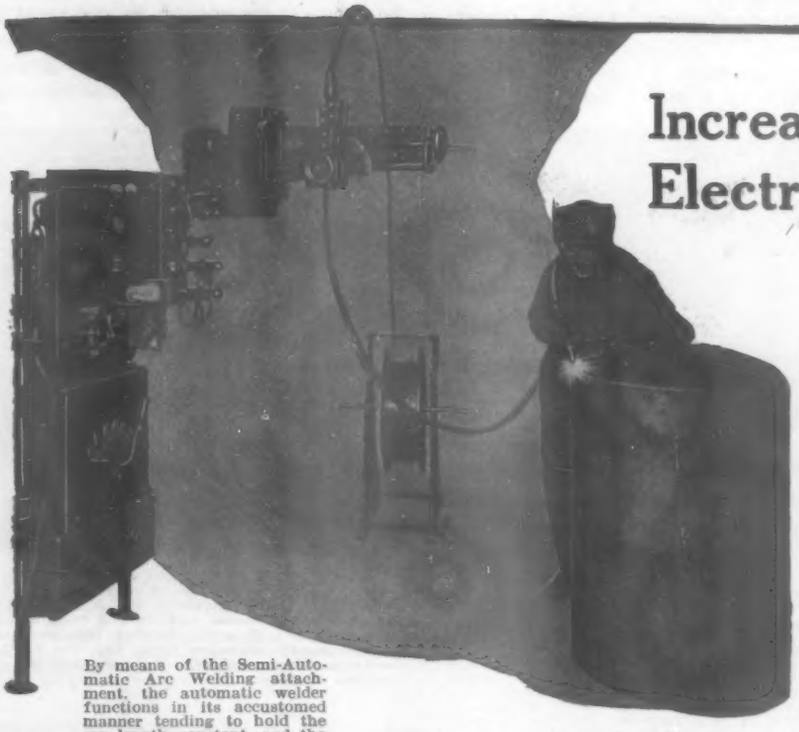
The importance, even the necessity of employing only properly trained operators is now generally recognized, if the best results are to be obtained. Proper training is best effected by teaching the welder to recognize any defects he may introduce into the weld. He should then be shown by actual breaking of the weld the results of including these defects. This is best done by the use of testing machines so that the actual strength, elongation, angle of bend, etc., may be measured and the progress of improvement noted. The encouragement derived from knowledge of better work accomplished is an incentive to attain still higher standards. By the use of frequent tests to check their work, even welders who are generally regarded as experts have found that they can improve the quality of their work in instances as much as 25 per cent.

It is only recently that the importance of the correct selection of the welding rod has received any considerable share of the

---

*Paper read before the annual convention of the International Acetylene Association, New York, October 4, 5 and 6, 1921.

†Union Carbide and Carbon Research Laboratories, Inc., Long Island City, N. Y.



By means of the Semi-Automatic Arc Welding attachment, the automatic welder functions in its accustomed manner tending to hold the arc length constant, and the operator merely directs the arc as required by the particular job.

Increase Your Use of Electric Arc Welding

Advantages

Saves time ordinarily lost in changing electrodes.

Saves 10% to 25% in electrode material ordinarily thrown away as waste ends.

Operators learn to use it quickly, as they do not require the muscular training for hand welding.

Continuous operation results in few interruptions in the welding, eliminating a source of defective welds.

This new G-E device can be attached to any G-E Automatic Arc Welding head in such a manner that the electrode wire passes from the feed rolls into the flexible tubing and thence to the arc through a guide nozzle in the welding tool.

Automatic electrode feed—hand work

The G-E Semi-Automatic Arc Welding Lead is a device to be attached to the G-E Standard Automatic Arc Welder which obtains the continuous welding features of the automatic welder, and permits the operator to direct the arc as required by the conditions of the work.

This new device consists of a welding tool to be held by the operator, which acts as a guide for the electrode wire. In the handle of the welding tool there is provided a switch for operating the control on the panel of the Automatic Welder. Attached to the welding tool is a 10-ft. length of flexible steel tubing (called the flexible wire guide) with an adapter at the other end for attaching it to the automatic welding lead.

By means of this attachment the operator can work on products where the seam to be welded is of very irregular contour, or on large work where the clamping and travel mechanism for full automatic welding would be complicated and costly.

General Electric Company

General Office Schenectady, N.Y.

Sales Offices in all large cities

43B-639

recognition that it merits, and that researches have been carried out for the improvement of existing rods and the development of new rods.

General Consideration in the Selection of Welding Rods

Unfortunately, the practice has too often been to fill a steel weld with whatever steel rod happened to be at hand, or to weld copper with a plain copper wire, the general character of the metal in each instance determining the most convenient filler at hand, without reference to scientific balance of component elements. The results of such methods have frequently been disappointing.

A better procedure is to use a rod that will produce a joint as good as or better than the original or base metal. In this connection it is well to bear in mind that the metals joined are usually in the rolled or forged condition, while the metal deposited from the welding rod is in the cast condition. Very often a metal is of such composition as to possess excellent properties after forging and heat treatment, but in the form of the casting is of little value.

This is well illustrated by the comparison of chrome-vanadium steel. After forging and careful heat treatment these steels have a tensile strength in the neighborhood of 150,000 or even 200,000 pounds per square inch and are highly resistant to shocks and to alternating stresses. In the cast condition the tensile strength is very little better than that of unalloyed steel of the same carbon content.

A further consideration is that the welding operation frequently causes a change in the chemical composition as the metal of the rod is fused into the weld. For example, an 11 to 13 per cent manganese steel is widely used where resistance to wear and shock is required. A welding rod of this composition will yield welded steel containing 90 per cent to 100 per cent manganese, which is so brittle as to be without value. The solution is to use a rod containing at least 14 per cent manganese, which will yield weld metal of the correct 12 per cent manganese content.

In order to obtain a high grade weld it is necessary to fuse the edges of the base metal and the welding rod at the same time, and to obtain an intermingling of the two metals. The product of this mixing may be entirely different from either of the original metals. This may be illustrated by attempts that have been made to weld cast iron with steel rods. The mixture of the metals at the junction is weak, brittle, hard to machine, and lacking in the good qualities of either steel or cast iron. However, when the product is not required to stand severe strains or shocks there are certain instances when steel may be welded to cast iron.

The composition of the rod should be such that during welding the metal is not so liquid as to run easily over the unfused metal, covering up improperly fused and oxidized surfaces, nor should the melted metal be so viscous as to pile up and cause difficulty in obtaining a weld that is homogenous and smooth at

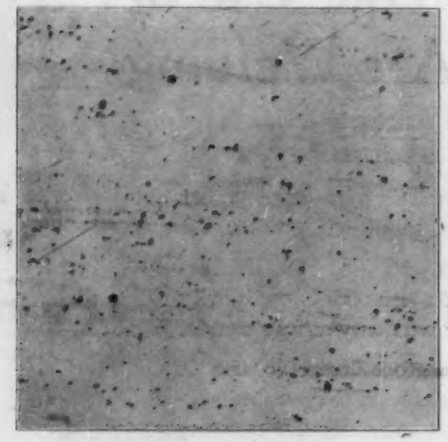


Fig. 4—Unetched. Showing impurities in 0.02 per cent carbon steel rod. The majority of these inclusions are aluminum oxide. Upon welding with this rod a granular appearing slag formed on the surface of the melted metal and made it difficult to obtain a clean weld.

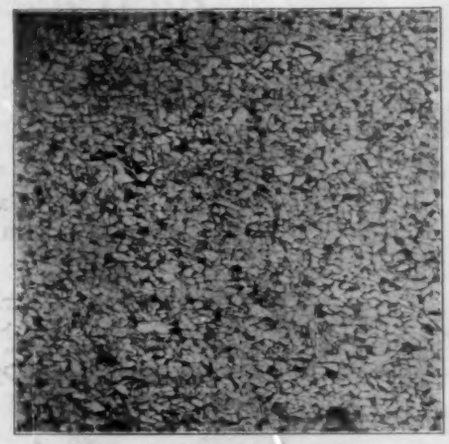


Fig. 5—Structure of steel rod containing 0.20 per cent carbon. Dark areas are pearlite, the carbon carrying constituent, and light areas ferrite.

Fig. 6—Weld made from 0.35 per cent carbon steel rod. The Widman-statten-like structure is characteristic of medium carbon steel that has cooled undisturbed from a high temperature. A weld showing this structure is frequently stronger than the low carbon weld previously shown, but its ductility is seldom as good.

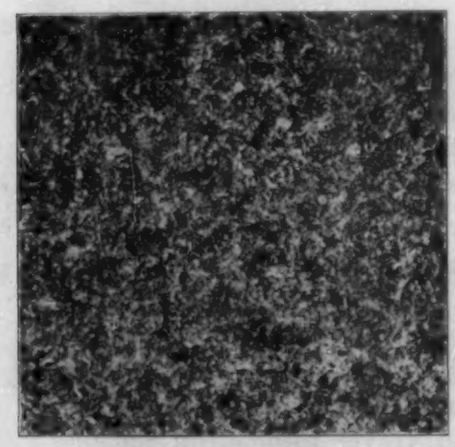


Fig. 7—0.90 per cent carbon steel. This eutectoid steel contains just enough carbon that neither free ferrite nor free cementite is formed.

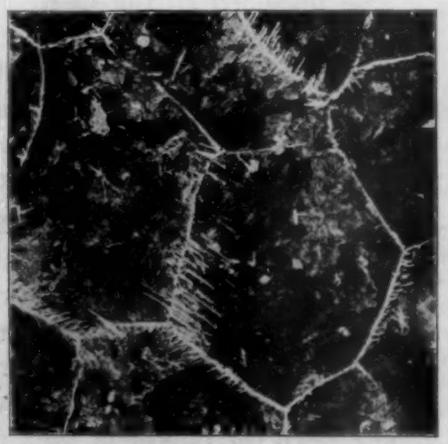


Fig. 8—Structure of weld made from rod shown in No. 7. The grains are quite large and the steel in this case is largely sorbitic. This weld is relatively hard and resistant to wear, but is of lower tensile strength than lower carbon steel welds.

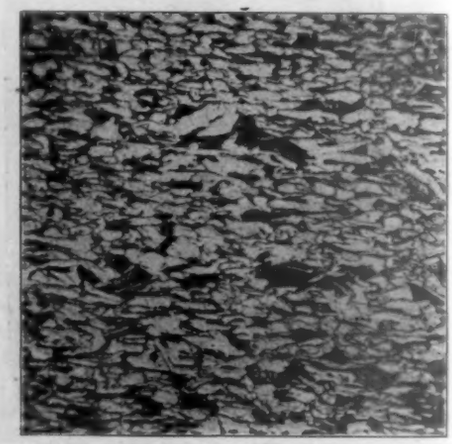


Fig. 9—Cold drawn nickel steel rod. Carbon 0.24 per cent, nickel 3.50 per cent. The elongated grains are due to the deformation set up by the reduction during the drawing operation.

the surface. A satisfactory rod will be sufficiently free from impurities and of such composition that the slag formed by welding will fuse and float readily to the surface of the molten pool. A very thin slag has the advantage of protecting the metal surfaces from oxidation, and when present in small amount is not readily entrapped in the weld.

Manipulation is easier and attended with greater success when the melting points of the rod and the metal being welded are approximately the same. Where there is considerable difference the low-melting-point metal is overheated and damaged before the higher-melting-point metal is fused.

This rate of fusion also makes important the exercise of care in choosing the size of rod and welding head for a given weld. The heat supplied should be sufficient to keep a small pool of molten metal in the weld and to melt in additional metal from the rod. If the rod is too large it will tend to chill the molten bath and may sufficiently lower the temperature to retard or virtually stop fusion of the rod metal into the weld. On the other hand, if the rod is too small it will not absorb the heat of the flame and pool rapidly enough, and the excess heat which results in the weld will burn the metal.

The usual method of manipulation is to melt a small pool of the base metal and then insert the rod in the molten pool. By this method the rod absorbs the heat necessary to melt it down and at the same time prevents the temperature of the molten pool from rising far above its melting point. The principle is the same that governs the temperature of water containing ice: It cannot be heated to a temperature higher than that of melting ice until the last of the ice is melted.

The torch is gradually moved along the weld and all slag is floated to the surface and laps or cold shuts melted out, the rod being kept constantly in the pool to supply metal for filling. Care is always exercised in manipulating the rod to avoid pushing the fused metal over the unfused metal.

The covering of unfused surfaces would produce the difficulty commonly called lamination, which is similar to the seams that sometimes occur in the rolling or forging of steel. This method of holding the rod suspended in the molten pool aids in the production of a clean weld, because it keeps the melting metal covered by the pool, prevents any oxidation below the surface, and makes it improbable that any oxidation or foreign matter will be carried to the interior of the weld. Furthermore, the neutral gases when directed at the weld adjacent to the rod, envelope both the rod and the bath in such a manner as to exclude atmospheric oxygen from the weld, so that excessive oxidation cannot occur when the filling rod and the blowpipe are properly manipulated.

Welding Rod Materials and Their Composition

Since the selection of the rod depends on the service requirements of the finished weld, it may be well to consider briefly a few of the better known rods and the conditions under which they may be used to the best advantage.

The most important of the welding rods, if we judge by the quantity consumed, is Norway iron which, though really a steel, approaches closely to pure iron. A weld made properly with this rod will have a tensile strength of over 50,000 pounds per square inch and an elongation of from 25 to 30 per cent in two inches, thus combining high strength and excellent ductility.

The next in importance is the mild steel rod which contains 0.2 per cent carbon, and other elements in the usual percentage. Norway iron and this material may be used interchangeably, depending largely on the operator's preference. The mild steel rod ordinarily gives a weld of higher tensile strength but of slightly lower ductility.

The following table illustrates the tensile properties of welds made by a properly trained operator using the mild steel filling rod. Note the practical uniformity in the results of the successive welds:

Sample Number	—Lbs. per Sq. In.— Yield Point	Ult. Ten. Strength	Elongation in 2 inches	Contr. of Area	Fracture
1	36,000	54,150	10.0	18.6	Fine crystals
2	34,550	55,400	14.0	20.6	Silky
3	36,420	56,700	16.0	16.0	Silky
4	35,150	55,100	12.0	14.4	Fine crystals
5	37,150	53,200	10.0	18.6	Silky
Average	35,850	54,850	12.4	17.6	

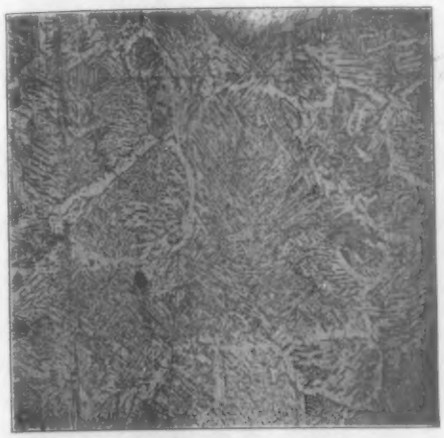


Fig. 10—Weld metal obtained from nickel steel rod. One small slag inclusion is shown, otherwise the weld is quite clean and free from defects.

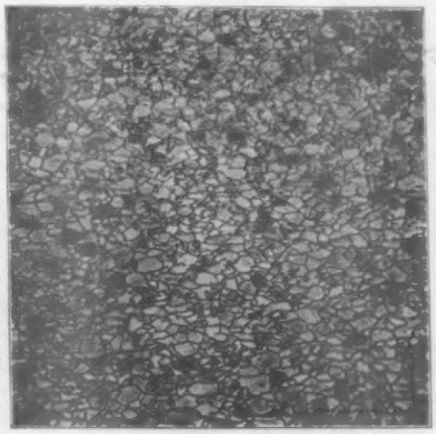


Fig. 11—Manganese steel rod. Magnification 425 diameters. The small light colored grains are austenite, which is a rather unstable constituent. Relatively low temperature heating will cause it to break down into martensite, which is hard and brittle. Mechanical working as machining or filling has a somewhat similar effect; after first cut is taken the portion adjacent to the cut becomes unmachinable.

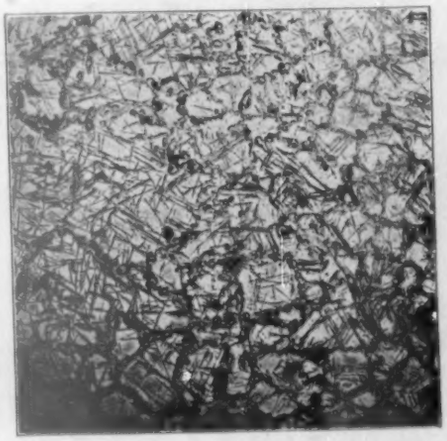


Fig. 12—Manganese steel weld metal. Here the austenite grains have partially disintegrated and martensitic structure is observed. This material is shown in the welded condition before being heat treated. Surrounding the grains can be observed thin, white lines of carbide. This material is present in such small amount as to be without value for strengthening the metal but serves as a weak brittle binder between the grains. Correct heat treatment will change this metal to the desirable austenitic condition.

Fig. 13—This photograph at two diameters shows a section of cast iron as welded with the oxy-acetylene torch. The weld is free from blowholes or slag inclusions and a perfect intermingling of the weld metal and plate metal has been obtained.

These values were obtained in testing welds in ship plate of 60,000 pounds per square inch tensile strength. They are not isolated or exceptional in any sense, being merely good average welds. The specimens were machine over all in order to make it possible to secure accurate measurements.

High carbon welding rods are employed for building up worn shafting and for many other common uses where metal is required of sufficient hardness to resist wear and tough enough to resist shocks and other stresses. The carbon content of these rods may vary over a rather wide range, depending on the requirements of the finished welds.

Welds have been obtained that have a Brinell Hardness higher than 400, which is too hard to machine. However, any hardness in the range from a very mild steel of Brinell number below 100 up to the highest value can be obtained by the selection of a rod of suitable chemical composition.

Steel that has been subjected to mechanical work as in rolling or forging is strengthened by increasing the carbon content, but an increase of carbon in steel welding rods does not greatly increase the tensile strength of the resulting weld. This is due to the fact that the weld is essentially a casting and the weld metal forms in larger and weaker grains as the carbon content is increased, and to the added fact that welders have greater difficulty in obtaining sound welds with the higher carbon steels.

There are a few very skillful welders who have obtained excellent success with nickel steel welding rods containing 0.20 to 0.25 per cent carbon and 3.0 to 3.50 per cent nickel. Many other welders obtain poor results with this steel owing to cracks that form in a weld while it is red hot. The tendency to crack is due to the well known brittleness of nickel steel at high temperature. This property is illustrated by the difficulties so frequently encountered in forging nickel steel and by high temperature tensile tests showing that nickel steels as compared with other steels decrease rapidly in ductility at high temperatures.

Operators who are sufficiently skilled in handling nickel steel rods can make welds having a tensile strength as high as 60,000 pounds per square inch. This strength is greater than that of low carbon steel plate, such as boiler plate for example, and when tensile tests are made the break does not occur in the weld but generally several inches away in the plate metal.

High speed steel rods are rather widely used for making tipped tools. The high speed steel is melted into a slot cut from the end of a low carbon steel shank. After correct heat treatment the cutting qualities of the high speed steel deposited by the oxy-acetylene welder are as good as the high grade commercial brands of high speed steel. The melting causes very little change in the chemical composition, usually a slight reduction of the contained silicon and manganese, so the rods used should have about the same composition as a standard high speed steel. By using this process a heavy tool can be made up of inexpensive mild steel shank, and the small tip only of high speed steel. A wide variety of shapes and sizes of tools are thus made available without tying up an appreciable amount of money in costly material, as is the case when solid high speed steel is used. The requisite for success here as with every high speed steel is correct heat treatment.

Manganese rods are employed in the repair of machinery used for grinding and for other service where great resistance to abrasion is required. As previously explained, the manganese content of the rod should not be less than 14.0 per cent.

Special precautions are necessary in welding this steel. The part to be welded should be supported so that the heated portion will be under as little strain as possible; it should be preheated to redness before the welding is begun and kept red hot during the operation. In this steel the favorable properties of great resistance to shock and abrasion are brought out by quenching in water from a temperature of about 1,800° F. In order to obtain the best results after welding, the quenching practice employed in manufacture should be closely followed.

One of the commonest of oxy-acetylene welding operations is the welding of cast iron. The expenditure of a few dollars for welding in this field may easily result in the salvage of a casting worth several hundred dollars. The composition of the

Fig. 14—Unetched. Gray cast iron, unetched. Large plates of graphite tend to weaken the metal.

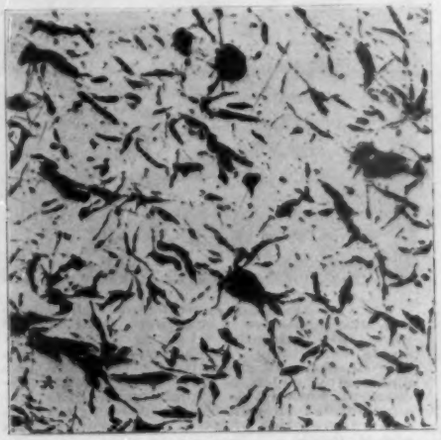


Fig. 15—Unetched. Gray cast iron weld metal. Here the graphite flakes are of smaller size and the metal is even stronger than the casting because the continuity of the metal is greater.

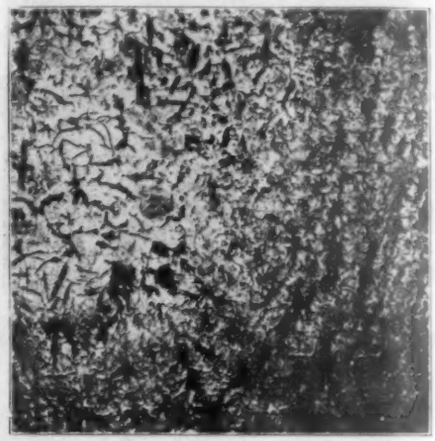


Fig. 16—Gray cast iron. 50 diameters. Weld junction, with weld metal on left and original cast iron on the right. Much smaller graphite plates in weld metal. Good fusion of the two metals and no impurities or hard spots can be observed.

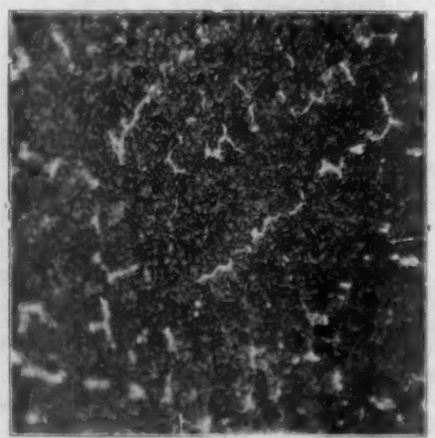


Fig. 17—High speed steel weld metal magnified 425 diameters. This material has been correctly heat treated and has proved to be an extra good tool, as shown by service tests. Most of the carbides have been absorbed during the heat treatment. The ground mass is martensitic with outlines of the original austenic grains still remaining.

rods used for this work is that of ordinary grey cast iron, the silicon content of which should be relatively high and the percentage of sulphur low. Excepting for certain special uses, grey cast iron is standard. Increasing the silicon content reduces the amount of carbon retained in solution during cooling, resulting in the deposition of a larger portion of it in thin graphite flakes throughout the cast iron. It is this structure which gives the fracture of grey iron its characteristic appearance. Grey iron is less brittle than white iron and is readily machined, while white iron cannot be machined. When rods of correct composition are used the weld metal obtained is usually as strong as the original casting. The tensile strength of a cast iron weld is about 18,000 to 20,000 pounds per square inch and the transverse test of 1-inch square section using a 12-inch beam loaded at the center is from 2,000 to 2,500 pounds with a deflection of 0.1 to 0.15 inches.

Rods used for filling welds in copper are made of copper to which has been added a small amount of phosphorus as a deoxidizer. When red hot copper is readily attacked by oxygen, which has a very deleterious effect on its physical properties. Phosphorus arrests the absorption of these oxides into the weld and for this reason copper should never be welded excepting with a filler rod containing phosphorus or some other suitable deoxidizer.

Very encouraging results are being obtained in the tensile strength of the welded metal. Indeed, it is felt that users of copper are not sufficiently aware of the advantages oxy-acetylene welding offers, and a great expansion of that field in the near future is confidently expected. Until recently only about 14,000 pounds per square inch tensile strength was obtained in copper welds, but improvements in rods have made possible the production of welds testing over 22,000 pounds per square inch.

Brass is successfully welded, rods of the usual brass compositions being satisfactory for this use. There is some loss of the zinc content—about two or three per cent escaping in the form of fumes during welding; and where much of this work is done proper ventilation should be provided to protect the workman from the poisonous vapor. A suitable flux is always used in welding on brass or bronze. The flux forms a thin slag, coating over the weld preventing oxidation and at the same time dissolving impurities and floating them to the surface of the weld.

The most popular bronze welding rods are the manganese and Tobin bronzes. They are used for welding bronzes and for building up worn bronze surfaces and also for brazing, which though really a soldering operation is capable of effecting joints of great strength. A wide variety of metals may be joined by brazing. Among these metals malleable iron should be mentioned. Although welding destroys its good properties, very high efficiency results when a brazed joint is employed.

Aluminum welding and soldering by the oxy-acetylene flame has a widespread use both in manufacturing and in the repair of broken parts. The welding of broken crank cases is one of the regular services offered by most up-to-date automobile repair shops. Rods of pure aluminum as well as special rods of aluminum with zinc or copper additions are widely used and have met with much success.

Inspection and Tests of Rods

Even though they may be of correct chemical composition, experience has shown that some rods are unsuited for welding. Any one of the manufacturing operations of melting, casting, rolling, cold drawing, etc., may not have been correctly handled, resulting in a faulty product. It is essential that the rods be made by good manufacturing practice.

Investigation of several curious failures of welding materials has focused attention on certain factors that as yet remain somewhat obscure. Welding rods are encountered occasionally that are not satisfactory in their welding properties, even though chemical analysis of the material shows that the proportions of the elements usually specified are correct. This trouble has not been found alone in rods but in certain lots of sheet metal, as was recently demonstrated in an investigation of sheet steel that did not meet the requirements of a certain manufacturer for welding. The rod was satisfactory, the equipment and welding procedure all that could be desired, and still it was not possible to make a satisfactory weld. Here again even most careful metallographic examination failed to reveal conclusive evidence of the cause of non-weldability. A simple test in which none of the factors of torch operation or gas fusion entered, proved that it was impossible to melt the given steel and obtain a solid fusion free from blowholes and sponginess.

This example is mentioned to illustrate that as yet we do not know all there is to be known of the physico-chemical reactions taking place when the melting of a welding metal occurs. Difficulties may arise that can be traced back to the melting stages in the manufacture of the steel itself. Occluded gases or dissolved oxides and other potent mischief-makers because of their reaction at torch temperatures, may liberate gases which will render unsatisfactory the most carefully made weld. These examples are mentioned to bring out the fact that the steel-maker and foundryman share with the welder himself some of the responsibility and should work with him in solving the problem of making better welds.

Purchasers of rods may protect themselves by careful inspection and tests. Each grade of material should be tagged and given a distinctive marking, and the different grades should be kept in separate places, so that mixing of the rods will be avoided. The surfaces of the rods should be free from lime or scale or rust. Among the impurities that rods may contain are slag inclusions, oxides and dissolved gases. Slag inclusions in the rod will be deposited in the weld and only with great skill and care will be floated to the surface. One of the most objectionable impurities in the welding rod is the aluminum oxide which results from the aluminum which is added to the steel as a deoxidizer during manufacture. While, if the manufacturing practice is right, it is not necessary to use sufficient aluminum to make trouble, an excess of aluminum resulting from careless manufacture is sure to present difficulties to the welder in the form of alumium oxide. During welding the presence of aluminum oxide causes a granular appearing refractory slag to form on the surface of the melted metal, and difficulty is encountered in preventing some inclusion of this slag in the weld.

Iron oxide is readily dissolved in low carbon steel, and when present in the rod it can never be eliminated by the welding operation. Excessive oxides in the rod render it hot short, and their presence to excess may be detected by heating the rod to a bright red and bending quickly. A properly deoxidized steel rod will not break or crack from this treatment.

When, due to faulty manufacture, dissolved gases are present in the rod or plate metal, they will be evolved during the welding process, and when the metal cools it will be left in a weak porous condition. A very satisfactory test of welding rods is to place several short lengths beside each other on the welding table and fuse them together. Then from other samples of the same lot build up the metal to twice the thickness of the rods. The workability of the metal may be observed, and the volume and character of the slag and any evolution of gases can be noticed. This test specimen should be broken and the toughness and ductility as well as the appearance of the fracture noted. These observations, together with those made during welding, should enable the purchaser of rods to know rather definitely whether or not the particular kind of rod thus tested is suited to his requirements.

Physical Tests of Welds

Until very recently there was no recognized standard for the testing of welds. Leaders in the industry have recognized the need for a uniform practice in testing, so that a greater knowledge of the properties of welds will be available through the exchange and assembling of information and test data. This need of standardization has been met by the American Bureau of

(Continued on page 40)

The Welding Engineer

Reg. U. S. Pat. Office.

Published on the 17th of Each Month by

THE WELDING ENGINEER PUBLISHING CO.,

608 S. Dearborn St., Chicago, Ill.

Telephone Wabash 7134.

L. B. Mackenzie.....President and Editor
H. S. Card.....Associate Editor
R. L. Miles.....Associate Editor

Subscription payable in advance and postage free.
United States and possessions and Canada.....$3 a year
Foreign Countries ..... 4.00 a year
Single copy, domestic .....25 cents
Single copy, foreign .....30 cents

Entered as second-class matter January 20, 1916, at the postoffice at Chicago, Illinois, under the act of March 3, 1879.

The Welding Engineer is a member of the Audit Bureau of Circulations and of the Associated Business Papers, Inc.

Last Advertising forms close at 8:00 a. m. on the 15th. To show proof for correction copy must be received at an earlier date and allowances should be made for delay to mails.

The Welding Engineer does not publish in its news or advertising columns any matter that deals with or refers to either personal or legal controversies.

The Welding Engineer is the official organ of the American Welding Society.

The Welding Engineer in Australia and New Zealand.

Mr. R. Hill, Matlock House, Devonport, Auckland, New Zealand, is our accredited representative in Australia and New Zealand for obtaining new subscriptions.

VOLUME 7 JANUARY, 1922 NUMBER 1

Contents for January

Progress of the A. S. M. E. Boiler Code..... 21
Pinch-Hitting with the Torch..... 22
Large Transformer Case Repaired by Welding..... 23
Increasing Welding Speed..... 24
Locomotive Boiler Welding..... 26
Mechanical Helps for the Torch..... 29
Oxy-Acetylene Welding Rods..... 32
Editorial 38
Cement Mill Machinery Reclaimed by Welding..... 40
Efficiency of Arc Welded Rail Joints..... 41
Refabricating Structural Steel..... 47
Increased Business as Related to the Cutting and Welding Trade 48
Reclaiming Ice Cans by Welding..... 50
Who's Who 52
Current Welding Literature..... 56

Good Vision Speeds Production

EYE protection has always been a vitally interesting subject to the welding industry, mainly as a preventative against possible damage to vision from exposure to the flame or the arc. There is a reason for protection of vision against damage which outweighs considerations of physical comfort. That is the relation of good vision to the efficiency of the workman. Any constant use of the eyes at close range causes an unnatural strain and impaired vision. It has been pointed out that not half the people who ought to wear glasses are wearing them. Glasses which correct the vision make it possible for the wearer to perform his duties to better advantage, and goggles which protect the vision serve to lengthen the wearer's period of maximum usefulness. Boilermakers are up near the top of the list of those who need glasses. Welders are probably nearer the top than boilermakers. A good bit of advise to beginners would be, "get *glasses* if you need them, and wear goggles *always* when welding." The matter of increasing output by correcting vision has passed the experimental stage, so it is not new to have reported a 25 per cent increase in production through doctoring the eyes. It is vastly more practical, economical and humane to increase a workman's efficiency 25 per cent than it is to cut his wages 10 per cent.

How to Advertise the Job Shop?

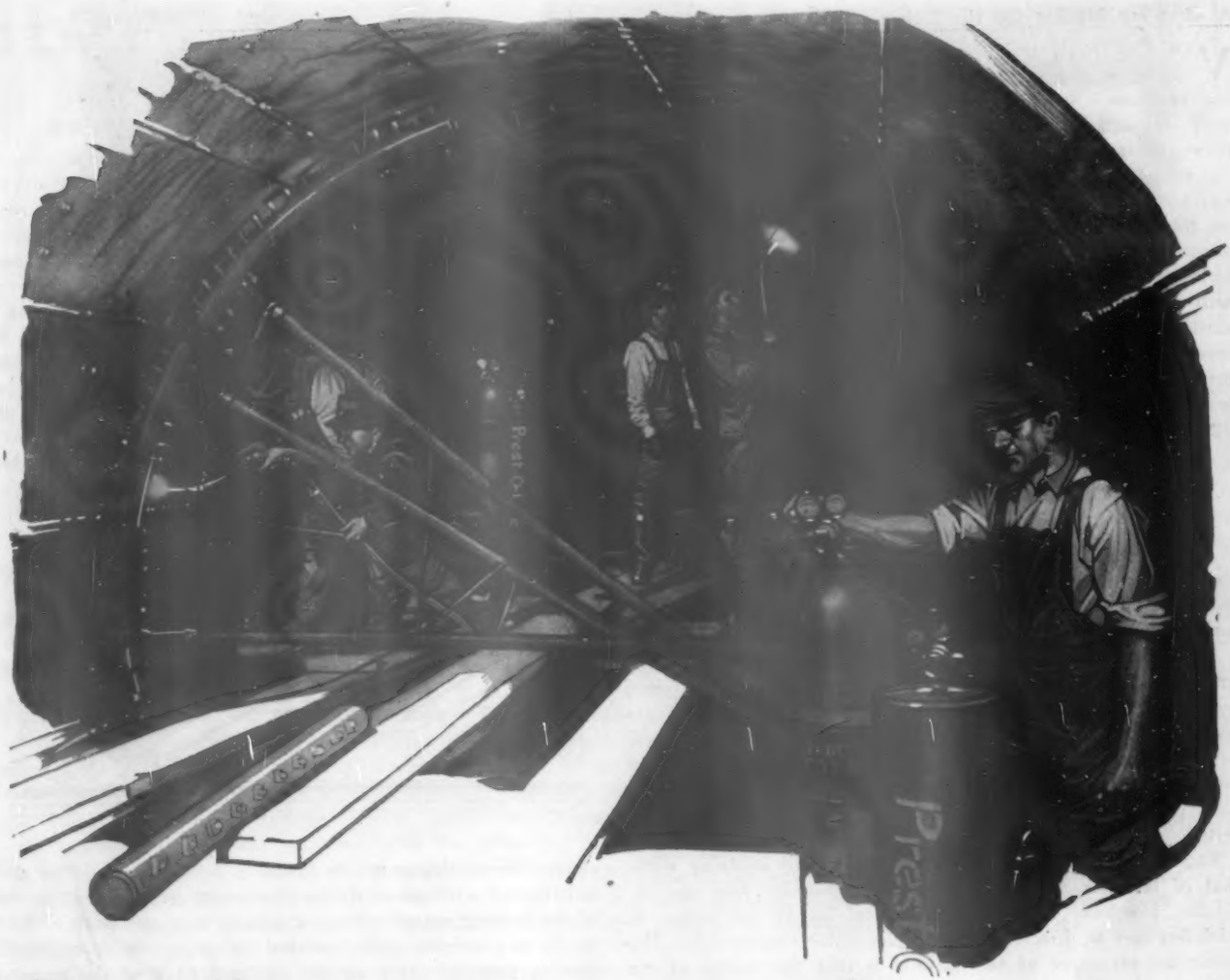
IS there any "best" way to advertise the job shop? Can welders supply from their actual experience a dependable, year 'round method of getting new customers, especially in the smaller communities? How do results compare when newspapers, broadsides, telephone books, billboards and circular letters have been used? The experiences of a few welding shops would be of immense benefit to the entire industry right now when "business is geeting better." A short time ago one welding shop put a circular, describing his business in the hands of every family and business house within three miles of the shop. The circular was a plain type affair, printed on cheap newsprint paper. The manager stated afterwards that he was unable to trace a single result. He had tried circular letters to selected lists, he said, with very good results, and all his other publicity efforts had been non-productive. Were they really non-productive, and, if so, why? *The Welding Engineer* wants to hear about plans that have worked and plans that have failed. Pass along your ideas and experiences for the benefit of the other fellow. You may profit in your turn from what the other fellow has to say.

A Job Welder's Forum

ANNOUNCEMENT has been received from the Cleveland Section of the American Welding Society of a series of practical meetings for job shop welders, open to all welders without card or cost. Problems will be worked out by practical men in a practical manner at the Cleveland Y. M. C. A. Shop, under the direction of Mr. Royal D. Mahn, Chairman of the Cleveland Section. The shrewd job shop welder will cancel all other engagements and get the most out of these meetings. Adoption of this plan by other sections of the society would undoubtedly result in a considerable membership increase.

The Welding Engineer Index for 1921

AN index of the 1921 volume of *The Welding Engineer* has been prepared and will be mailed to all subscribers who request a copy. The index will tell at a glance what subjects have been covered in the preceding twelve issues, something of the nature of each article, and the names of authors wherever they are available. It has not been assumed that every subscriber will ask for a copy so the supply is limited, and orders from non-subscribers will not be filled until it is fairly certain that all paid subscribers who wish the index have been supplied with it.



Two miles of seamless copper tube a hundred feet underground!

The job illustrated—that of lining two miles of the Catskill Aqueduct with copper—shows in a compelling manner the extreme portability of

Prest-O-Lite

DISSOLVED ACETYLENE

Without gas—ideal for both welding and cutting—in such conveniently transportable containers — the oxy-acetylene process would lose much of its usefulness.

Whether the work be at the top of a sky-scraper or deep under the surface, indoors or out — Prest-O-Lite goes to the job!

A nation-wide service built around forty plants and warehouses insures a constant and prompt supply of Prest-O-Lite.

THE PREST-O-LITE COMPANY, Inc.

General Offices: Carbide and Carbon Building, 30 East 42nd Street, New York

Balfour Building San Francisco

In Canada: Prest-O-Lite Co. of Canada, Limited, Toronto

PW-504-21

A Growing Market for the Torch Salesman

VOCATIONAL training and vocational education are becoming more and more an accepted part of our teaching program. Schools are turning out potential craftsmen as well as potential sages. From all sections of the country come reports of the opening up of vocational schools as part of the common school system. Many of these schools will teach oxy-acetylene welding. This fact is indicated by the demand on the part of the directors of these schools for information about welding literature. Usually there will be found in the vicinity of the school a welder who knows the situation pretty well and can give the apparatus salesman a few good tips regarding his chances of getting some business. There is no reason why welding should not be taught in vocational departments, for boys of the school age are more receptive to good teaching than they will be after a few years of finding out what they "can get away with."

OXY-ACETYLENE WELDING RODS

(Continued from page 37)

Welding with carefully prepared specifications for testing welds, such that entirely comparable results will be obtained by experimenters who follow these specified methods of testing. The tests included are tensile, bending, fatigue, impact and metallographic.

The properties of the various metals that are welded are well known, and now that comparable tests of the metals when joined by fusion are being made by different investigators, much data may be expected to be available in the near future and we will be in a position to know just what to expect from a weld. The final test of the value of a welding rod is the quality of the weld produced, and this may be determined by these standard tests.

Examination by X-rays is a new method of studying welds that of late has received considerable attention. Any slag inclusion, blowhole, or interface in metal up to two inches in thickness may be detected by this radiographic examination. The particular advantage of this method is that the quality of the weld may be determined without the destruction of the weld as is the case in other tests.

Microscopic Examination

The metallurgical microscope is almost an unfailing aid when a study of the physical properties of a metal is undertaken. The examination of the entire surface of a large metal section at high magnification is very tedious and points of greatest importance might frequently be missed. The study of microstructure has been developed to help in avoiding these difficulties.

The metal section is polished and etched, and examination at low magnifications or with the unaided eye will disclose defects or non-uniformities in the compositon or structure of the specimen. Once the interesting or unusual features are located the examination at high power may proceed directly to the proper locations on the specimens.

REPAIR OF TRANSFORMER CASE

(Continued from page 23)

found to be perfectly sound, not even a pinhole having to be closed.

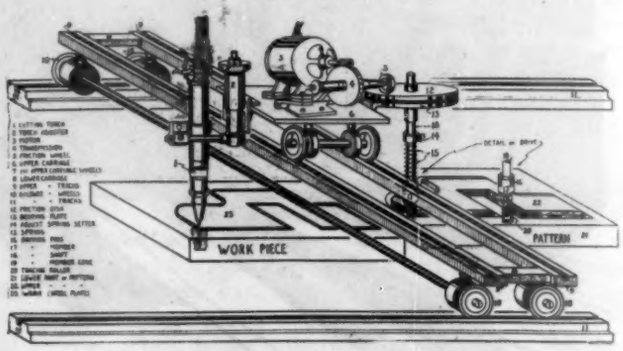
While the welding of the top, as previously observed, did not present the same difficulties that were encountered in repairing the base, it is worthy of comment that precautions were necessary to prevent warping, so that the top would fit flush with the lip of the case after welding. This was done, and the alignment was found to be without a flaw when the transformer and case were reassembled.

It is significant of the character of the repair just described that the Dublers, who are pioneers in the oxy-acetylene industry in Oklahoma, and who have handled almost every variety of work occurring in the mid-continent oil field, regard this particular repair as one of the most difficult jobs they have thus far had in their shop.

NEW AUTOMATIC CUTTING MACHINE

Announcement has just been received from the General Welding & Equipment Company, Boston, Mass., of the "Gewe" automatic cutting machine. The machine proper consists of a universal double carriage system, the upper carriage having four wheels running on a track and the lower carriage with four wheels running on another track. The two carriages run at right angles like a traveling crane so as to cover any point of a horizontal plane. On one side of the upper carriage is mounted a cutting torch with torch adjuster, and on the opposite side is mounted the cutting and tracing system. Thus the cutting torch and the driving and tracing system are rigidly connected.

A shaft carries the driving and tracing mechanism which



causes the cutting torch to follow a definite path. The shaft is provided with four driving pins which are received in slots of the driving member slipped loosely over the shaft. Partly by its own weight, partly pressed by an adjustable spring the driving member rests on the inclined edge of the template part it is knurled and hardened on its conical end so as to insure a reliable frictional driving engagement with inclined face. The shaft also carries the tracing roller, a small highly polished roller slipped loosely over a small pin at the lower end of shaft. This roller fits loosely in polished groove of lower part of template.

When the shaft is rotated the driving member will run along the inclined face of template part, pressing at the same time the polished tracer roller against polished face of groove, and keep constant engagement of driving member and tracing roller with their respective template faces, insuring uniform speed.

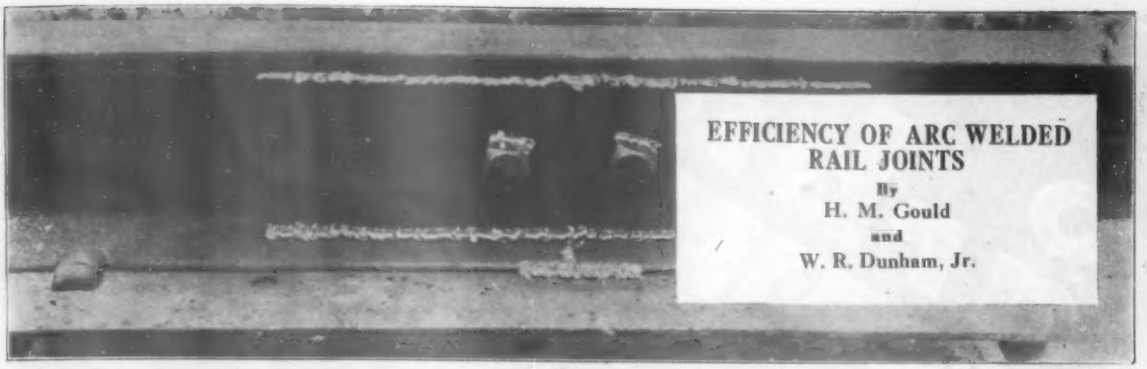
The speed can be regulated either electrically by a rheostat or mechanically by changing position or friction wheel on friction disc, or by both.

COMPRESSED GAS MANUFACTURERS BANQUET

The ninth annual meeting of the Compressed Gas Manufacturers' Association will be held in Assembly Room No. 2, on the fifth floor of the Engineering Societies Building, 29 West 39th Street, New York City, on January 16, 1922, at 2 P. M. It is hoped that a large number will find it convenient to have representatives there.

GENERAL MEETING OF G. P. A.

The general meeting of the Gas Products Association will be held January 20th and 21st, at Chicago. This meeting is the mid-year get-together for the electrolytic oxygen and hydrogen industry. Several important commercial and technical topics will be discussed. The meeting will wind up with an association dinner Sunday evening, January 21.



EFFICIENCY OF ARC WELDED RAIL JOINTS

By
H. M. Gould
and
W. R. Dunham, Jr.

EFFICIENCY OF ARC WELDED JOINTS

(Note:—This discussion consist of a discussion prepared by H. M. Gould, Electrical Engineer, Department of Street Railways, City of Detroit, Michigan, and W. R. Dunham, Jr., Chief Engineers, Engel and Hevenor, New York City, of Paper No. 310, "Investigation of Arc-Weld Joints" read before the A. E. R. E. A. at its convention held at Atlantic City, N. J., October, 1921. A number of interesting blue prints have been put at the disposal of The Welding Engineer, but space limitations make it impractical to reproduce all of them. However, complete details regarding any of the tests mentioned will be cheerfully furnished to those who desire them.—Editor.)

THIS discussion hinges principally upon two very pertinent statements appearing in the aforesaid report. The first statement appears in the second paragraph on page 22, and is as follows: "At its first meeting, the committee found a wide range in views as to the merits of this form of joint," and the second statement appears as paragraph number one at the bottom of page 45, and is as follows: "The art of electric seam welding as applied to rail joints possesses many attractive features."

The first statement accounts for the lack of standardization in all lines of engineering endeavor and particularly in the electric railway engineering field because personal opinions, unsubstantiated in a great many cases, are allowed to outweigh actual experience. This situation ought to be corrected and, judging from personal experience, the subject of arc-weld joints presents the right chance to carry this theory into execution.

If the railway industry as a whole is to receive the benefits which it is anticipated lie in the use of welded joints, reliable service data must be procured from the electric railway engineers who have actually installed joints of this character. In other words, each engineer should keep a detailed record of the type of joint installed, the date of installation, when the joint was repaired and why, etc. This record should be a continuous inventory supplemented by whatever remarks necessary to make the story complete and the entire story placed in the hands of the proper officials of the A. E. R. E. A.

Most engineers would be willing to do this as long as the reports were favorable, but they would doubtless be averse to supplying data which they imagine might be construed as showing poor judgment on their part in selecting the type of joint used or inferior workmanship on the part of their subordinates. For the good of the industry, such aversion, if it exists, should be overcome.

As examples of the information which should be supplied for the use of engineers concerned with track joints, reference is made to the comprehensive report given on pages 127 to 187 inclusive, in the 1905-1906 Proceedings of the American Street Railway Association and the report of the Board of Supervising Engineers, Chicago Traction, for the year 1910. A résumé of the latter report is given on pages 60 and 61 of Richey's "Electric Railway Handbook." If the men who supplied the information contained in the 1905-1906 report can bring this data up to date, and the Chicago data has been kept up to date, a very valuable acquisition would be made to the subject of track joints as regards the Thermit type, cast weld type, Lorain type—in fact most everything but the seam welded type. The next move is to procure such data from the standpoint of the seam welded joint.

The Department of Street Railways, City of Detroit, is willing to furnish whatever information it has relative to the subject of joint welding in the hope that such information may be of assistance to others who are using the seam welded joint or contemplate its use. Conversely, the department would like to have information of a similar character from other properties where the seam welded joint is used—further than that, information regarding all types of rail joints.

Referring to the second statement in the first paragraph of this paper, i. e., "The art of electric seam-welding as applied to rail joints possesses many attractive features" will be admitted without very much argument. Standard or non-standard joint plates can be used, the welding equipment is easily transported and handled (especially if the rheostatic welder is used), the cost of the welding equipment is not excessive and last, but not least, arc-weld bonds can be installed at the rail joints, as cross-bonds or in the special. In other words, the welding equipment necessary to seam-weld the rail joints is available for the necessary accessory work.

TABLE I.

Monthly Record of Welded Joints.

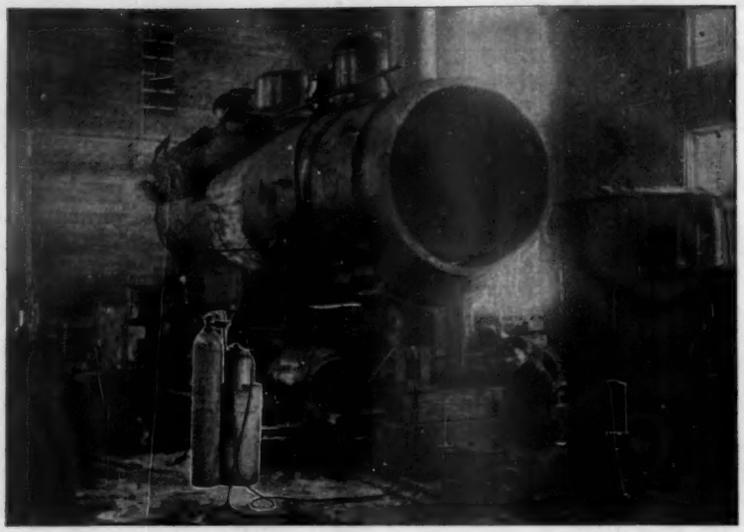
	Joints on Tangent Track				Compromise and Guard Rail Joints									
Month	91 lb. Rail	93 lb. Rail	100 lb. Rail	Total	91 lb. to 122 lb.	91 lb. to 140 lb.	93 lb. to 122 lb.	93 lb. to 140 lb.	100 lb. to 122 lb.	100 lb. to 140 lb.	122 lb. to 122 lb.	140 lb. to 140 lb.	Total	Grand Total
1920														
Oct.	342	...	....	342	..	...	.	..	..	..	..	...	...	342
Nov.	1684	...	....	1684	..	...	.	..	..	..	..	...	...	1684
Dec.	631	...	....	631	..	64	.	..	..	..	..	118	182	813
1921														
Jan.	119	...	....	119	..	8	.	..	..	..	..	24	32	151
Feb.	...	...	....	....	..	...	.	..	..	..	..	...	...	....
Mar.	428	...	....	428	..	12	.	..	..	..	..	13	25	453
Apr.	1014	343	....	1357	..	26	.	..	..	..	..	42	68	1425
May	483	548	1087	2118	8	40	.	..	20	..	57	50	175	2293
June	25	...	1241	1266	..	...	.	..	..	8	..	10	18	1284
July	70	8	165	243	42	40	.	8	..	24	..	104	218	461
Aug.	85	16	240	341	24	16	8	8	..	16	..	52	124	475
Sept.	6	19	9	34	..	...	.	8	..	..	..	27	35	69
	4887	934	2742	8563	34	206	8	24	20	48	57	440	887	9450

It might not be amiss at this time to call attention to the danger attendant upon placing implicit confidence in the seam-welded joint to the extent of considering it a panacea for worn out track. Seam-welded joints cannot act as substitutes for ties, ballast and pavement. As these joints lend themselves very readily to track rehabilitation work, there may be a tendency to expect too much of them.

A systematic method is employed by the Department of Street Railways, in keeping a record of the rail joints from the standpoint of location, date of installation, date joint was tested, the result of the test, etc. Sectional blueprints of all trackage are

Carbic

Portable Oxy-Acetylene Equipment



IN AND AROUND THE SHOP

Welding a crack 16 in. long in a locomotive cylinder at a cost of less than $7.00 is just an everyday job for the Carbic System.

Note the small size of the Carbic generator. It is really portable—weighs only 200 lbs. fully charged. Can be moved around the shop or yard by two men—yet will handle welding or cutting jobs large or small.

In addition to its portability, the Carbic System is absolutely safe and generates acetylene at half the cost of compressed acetylene. Also there is no gas tank or large generator investment.

Remember, the Carbic System is different from all others. Pure acetylene from Carbic Cakes of highest grade of calcium carbide. A few drums of Carbic guarantees your gas supply.

These are some of the reasons why the Carbic System is being used in hundreds of shops. Let us show what Carbic can do on **your** work.

The Carbic line is complete, including generators, torches, regulators and all other necessary apparatus and supplies.

Carbic Manufacturing Company

Duluth, Minnesota

Sales Offices:

NEW YORK, 141 Centre Street
BOSTON, 27 School Street
CHICAGO, 111 W. Washington Street
PHILADELPHIA, 18 South 7th Street

Representatives and Stocks in all Principal Cities

Carbic Cakes save money, time and patience, and yield a purer gas.

Trade Carbolite Mark

A ONE BRAND, HIGHEST QUALITY

CALCIUM CARBIDE

The trade name Carbolite has represented our product continuously for many years. Its appearance on each package is a guarantee of its excellence and a protection to our customers.

Carbolite is carefully manufactured from best grade raw materials insuring at all times a superior quality, both in purity and gas yield. Our modern screening and inspection system also makes certain a thoroughly clean product, uniform in size.

Carbolite is made in all standard sizes and can be supplied promptly from warehouse stocks.

Packed only in Yellow Containers

American Carbolite Sales Company

General Offices
DULUTH, MINN.

WAREHOUSES IN ALL CENTRAL STATES

kept on file with the location of all welded joints, bonded joints, bonded and welded joints, and cross bonds indicated. It is planned to include on the blueprints any and all information relative to the service performance of each joint, each cross bond and each special work bond.

From October, 1920, to September, 1921, inclusive, approximately 9,450 seam welded joints were installed, using the metallic

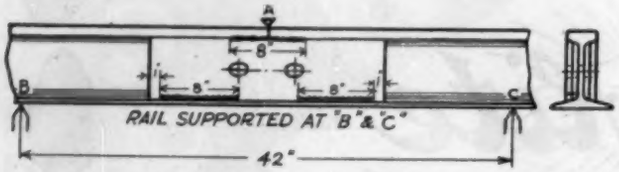


Fig. 1. Diagram of Case XIV.

arc—the number of joints installed month by month and the type and size of rails are shown in detail in Table I. Photographs showing the method and manner of welding the joints and blueprints, showing the details of the welding operations, were published in the October, 1921, issue of *The Welding Engineer*.

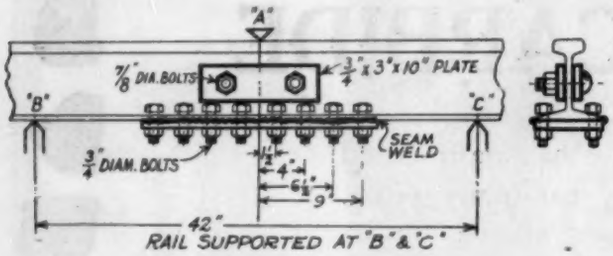


Fig. 2. Diagram of Case XV.

It was noted that, where wood ties are used in tangent track, every third tie rod is welded to the rails by spot welding the tie-rod nuts to the tie rod and the tie rod nuts to the rail webs, In curve track, every tie rod is likewise welded to the rails.

Where International twin steel ties are used, the tie at the rail joint is welded to the base of the rail as is every other tie. In addition, one tie per rail length (generally the third tie from the rail joint) has eight spot welds where the tie plates and channels are riveted together. This procedure has been adopted to insure absolute electrical continuity of the return circuit in case any rail joint failed—in fact, there would be a continuous electrical circuit if every joint failed.

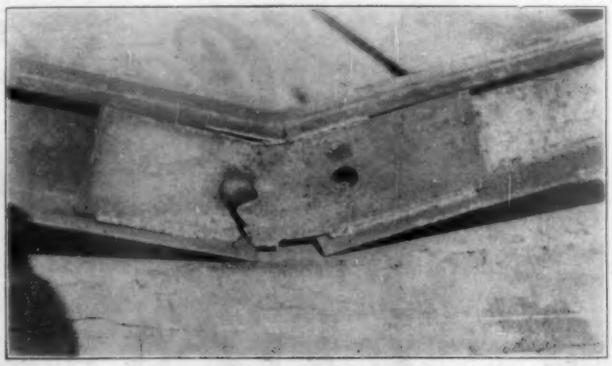


Fig. 3. Case XIV Outside of Rail.

Assertions have been made from time to time that the use of the electric arc has an injurious effect upon the texture of the rail, i. e., crystallization is induced. In order to prove or disprove this theory, seven temperature tests were made upon rail joints (four of the joints were actually installed in the track and three were constructed in the laboratory) using eleven indicating thermometers spaced five inches apart along the head of the rail. (These tests were described in detail and illustrated in the October, 1921, issue of *The Welding Engineer*.)

In one test the rail head was drilled and the five thermometer bulbs inserted to a depth of one inch. The maximum observed rail temperature was 239 degrees F. (air temperature 93.2 degrees

TABLE II.

Deflection in Inches.

Load in lbs.	Case 1.	Case 2	Case 3	Case 4	Case 5	Case 6	Case 7	Case 8	Case 9	Case 10	Case 11	Case 12	Case 13	Case 14	Case 15	Case 16	Case 17	Case 18	Case 19	Case 20	Case 22	Case 23	Case 24	Case 25	Case 26	Case 27	Case 28	Case 29
25,000	.0938	.0625	....	....	.3063	.125	....	....	.0625	...	...	.023	.053	.0312	.0312	.0625	.0625	.0312	.0312	.0312	.0625	.0625	.0937	.0937	.0625	.000	.0312	.0312
40,000	.2187	.1250	....	....	....	....	.0625	.1250	.0937	...	...	....	....	....	....	....	....	....	....	....	.0937	.0937	.1250	.2812	.1250	.0156	.0625	.0312
40,850	....	....	....	....	3.000	....	....	....	....	...	...	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
50,000	.4375	.2188	....	.125	....	.375	.1250	.2812	.2812	...	...	.091	.132	.0937	.0625	.0937	.0937	.0625	.0625	.0781	.0937	.0937	.1562	.4062	.1250	.0312	.0625	.0312
60,000	....	....	....	.187	....	....	.2187	.3437	....	...	...	.132	.215	....	....	....	....	....	....	....	.1093	.1250	.1562	.5000	.1406	.0312	.0781	.0312
70,000	....	....	.4375	.250	....	....	....	....	....	.187	...	.262	.346	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
75,000	1.3437	1.3125	.5000	.281	....	....	.3437	.4687	.7500	.219	.125	....	....	.3125	.1250	.1250	.1250	.0937	.0937	.0937	.1250	.1562	.1875	.6875	.1562	.0625	.0937	.0625
80,000	....	....	....	.312	....	....	....	....	....	.266	.125	.406	.553	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
80,200	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
83,600	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	.9375	....	....	....	....
86,000	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
90,000	2.2187	2.4063	....	.437	....	....	....	.6562	.9688	.296	.141	.953	.909	....	....	....	....	....	....	....	.1562	.1875	.2188	....	....	....	.1562	.0937
93,630	....	....	....	....	....	....	....	....	....	....	....	1.661	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
96,850	....	....	....	....	....	....	....	....	....	....	....	....	1.062	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
100,000	....	....	....	.499	....	....	....	....	....	....	.157	....	....	....	.1562	.1560	.1562	.1250	.1250	.1250	....	....	....	....	....	....	....	....
110,000	....	....	....	.562	....	....	....	....	....	....	.188	....	....	....	....	....	....	....	....	....	.1875	.2187	.2500	....	....	....	.1562	.1093
120,000	....	....	....	....	....	....	....	....	....	....	.203	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
121,320	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
125,000	....	....	....	....	....	....	....	....	....	....	....	....	....	....	.2500	.1875	.2187	.1875	.1875	.1560	....	....	....	....	....	....	....	....
130,000	....	....	....	....	....	....	....	....	....	....	.250	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
137,100	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
140,520	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
148,350	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
150,000	....	....	....	....	....	....	....	....	....	....	....	....	....	....	.4062	.3125	.3437	.2812	.3281	.2031	....	....	....	....	....	....	....	....
156,000	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	.3437	....	....	....	....	....	....	....	....	....	....	....	....
160,200	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
166,150	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	.4687	....	....	....	....	....	....	....	....	....	....	....
175,000	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	.4375	.5625	.3125	....	....	....	....	....	....	....	....

Case 1.	Test discontinued at 99,200 lbs.
Case 2	Test discontinued at 96,850 lbs.
Case 3	Plate split entirely across at 75,000 lbs.
Case 4	1 plate cracked all the way through at 110,000 lbs.
Case 5	Weld failed at 40,850 lbs.
Case 6	Plate broke at 85,330 lbs.
Case 7	Both plates cracked at 97,750 lbs.
Case 8	Both plates broke at 116,250 lbs.
Case 9	Both plates broke at 114,850 lbs.
Case 10	Plate broke at 117,000 lbs.
Case 11	Rail broke
Case 12	Broke at 90,000 lbs.
Case 13	Plate broken at 92,000 lbs.
Case 14	Plate broke on one side Rail broke at 171,920 lbs.
Case 15	Rail broke at 245,100 lbs.
Case 16	Test discontinued at 229,650 lbs.
Case 17	Test discontinued at 243,650 lbs.
Case 18	Test discontinued at 239,300 lbs.
Case 19	Test discontinued at 238,730 lbs.
Case 20	Rail broke at 160,200 lbs.
Case 22	Rail broke at 137,000 lbs.
Case 23	Base plate broke at 148,350 lbs.
Case 24	Bolts sheared off at 93,600 lbs.
Case 25	Rail broke at 86,000 lbs.
Case 26	Rail broke at 80,200 lbs.
Case 27	Rail broke at 121,320 lbs.
Case 28	Rail broke at 140,520 lbs.

F.) which occurred in the case of the thermometers inserted in the rail head. The maximum observed rail temperature when the bulbs were in contact with the head of the rail was 203 degrees F. (air temperature 82.4 degrees F.)

It is fair to assume that the rail has suffered no injurious effects from the application of the metallic arc.

Twenty-nine mechanical tests have been made to date upon rail joints and straight rails. These tests were made in an Olsen testing machine, the piece tested being supported on 42-inch centers and the load applied midway between the supports. Some of these tests were made before any track was laid and the balance have been made at various times since. The purpose is to develop a joint which will give the same deflection as a piece of unbroken rail and at the same time will be as strong as the rail itself.

Fig. 4. Case XIV Inside of Rail.

These joints, except one Thermit joint, one acetylene welded joint, and two joints bolted but not welded, were all constructed using the metallic arc. Different schemes were used both as regards the length of plate, the number of bolts and the amount and location of the weld. Special attention is called to the test of the joint under Case XV (Fig. 2), as this test, where the plate is bolted and welded to the base of the rails, shows results comparable with the tests made upon unbroken rails insofar as deflection and probable elastic limit is concerned. A dozen more joints of this same general character were made up, each one differing from the other as far as the amount of the seam weld, the number and location or absence of the bolts in the base, etc., is concerned. Some of these results appear under Cases XXII to XXIX.

A description of the various schemes used, with results noted in each case, follows:

The deflection in inches for various loads, in each case, is given in Table II.

Case III—Electric Arc Weld.

Ninety-one-pound 7-inch tee rail. ¾x20-inch plate. Two ⅞-inch bolts. Upper and lower edges of plate were scarfed to 45° and the seam welded full length.

Plates cracked from bottom scarfing.

Plates split entirely across at 75,000 pounds.

Case IV—Electric Arc Weld.

Ninety-one-pound 7-inch tee rail. ¾x20-inch plate. Two ⅞-inch bolts. Plates seam welded full length. One plate cracked all the way across at 110,000 pounds; both plates split on continuing load. Probable elastic limit of ¾-inch plates, 78,650 pounds.

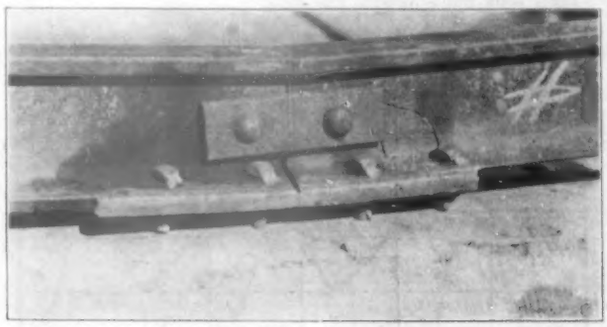


Fig. 5. Case XV Outside of Rail.

Case V—Electric Arc Weld.

Ninety-one-pound 7-inch tee rail. ¾x9-inch plate. Two ⅞-inch bolts. Plates seam welded full length, except for 2-inch lap at joint. At 35,900 pounds plate distorted and pulled away from welds on ends. At 40,850 pounds weld failed completely and rails spread about 2½ inches at bottom.

Case VI—Electric Arc Weld.

Ninety-one-pound 7-inch tee rail. ¾x20-inch plate. Two ⅞-inch bolts. Plates seam welded full length, except for 4-inch lap at joint. Plate broke at 85,330 pounds. Test continued until second plate broke.

Fig. 6. Case XV Inside of Rail.

Case VII—Electric Arc Weld.

Ninety-one-pound 7-inch tee rail. ¾x20-inch plate. Two ⅞-inch bolts. Plates seam welded 2 inches at each end and 4 inches at joint. Both plates cracked at 97,750 pounds. Bottom center welds sheared off. One end weld on each fish plate intact; all others started to shear off. All welds stood up in good shape until plate broke.

Case VIII—Electric Arc Weld.

Ninety-one-pound 7-inch tee rail. 26-inch Cleveland plate. Six ⅞-inch bolts. Plates seam welded full length. Plates cracked at 109,000 pounds and broke at 116,250 pounds. Welds on both plates, top and bottom, sheared off about half way back from joint, due to distortion of plates. Welds showed no signs of shearing until plates broke.

Case IX—Electric Arc Weld.

Ninety-one-pound 7-inch tee rail. ¾x20-inch plate. Two ⅞-inch bolts. Plates seam welded full length. Both plates cracked at 114,350 pounds. Bottom welds on both sides sheared off about one-third of way from joint. Top welds let go near joint. Welds held good until plates broke.

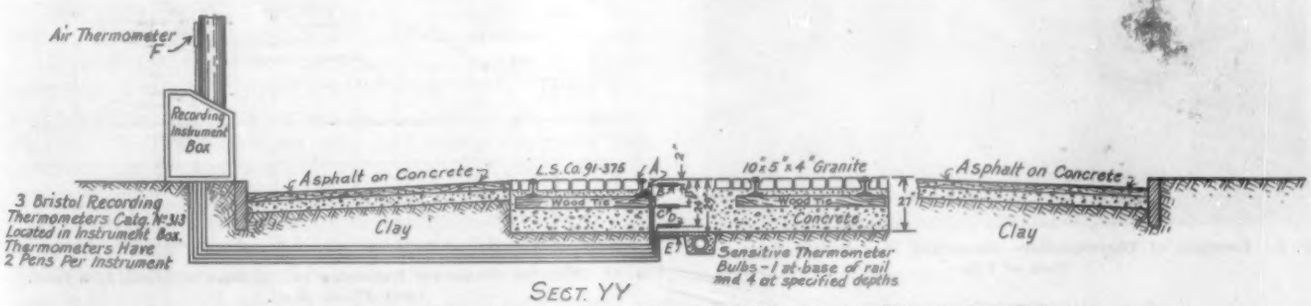

Air Thermometer F
Recording Instrument Box
Asphalt on Concrete
L.S.Co. 91-375
10"x5"x4" Granite
Asphalt on Concrete
3 Bristol Recording Thermometers Catg. №313 Located in Instrument Box. Thermometers Have 2 Pens Per Instrument
Clay
Concrete
Clay
Sensitive Thermometer Bulbs - 1 at base of rail and 4 at specified depths
SECT. YY

Fig. 7. Diagram of Location of Thermometers for Making Road Bed Temperature Tests.

Case I—No Welding.

Ninety-one-pound 7-inch tee rail. ¾x20-inch plate. Two ⅞-inch bolts. At 99,200 pounds, test was discontinued on account of bottom of rail touching base of testing machine. Small crack in plate near bolt hole. Plate and rail badly bent, bolt head slightly sheared.

Case II—No Welding.

Ninety-one-pound 7-inch tee rail. ¾x20-inch plate. Four ⅞-inch bolts. At 96,350 pounds, test was discontinued on account of bottom of rail touching base of testing machine. Small crack in plate near bolt hole. Plate and rail badly bent, bolts O. K.

Case X—Acetylene Weld.

Ninety-one-pound 7-inch tee rail. ¾x20-inch plate. Two ⅞-inch bolts. Plates seam welded full length. Acetylene weld made by Oxy-Weld Acetylene Co. of Detroit. Rails pre-heated before welding. Probable yield point 76,870 pounds. Plate broke at 117,000 pounds. Weld intact.

Case XI—Thermit Weld.

Ninety-one-pound 7-inch tee rail. No plate. Thermit weld made by Metal and Thermit Corporation. Rail heated before welding. The "center punch marks" on weld metal and rail metal indicated that the yield was taking place in the weld metal. The failure seemingly took place outside the weld.

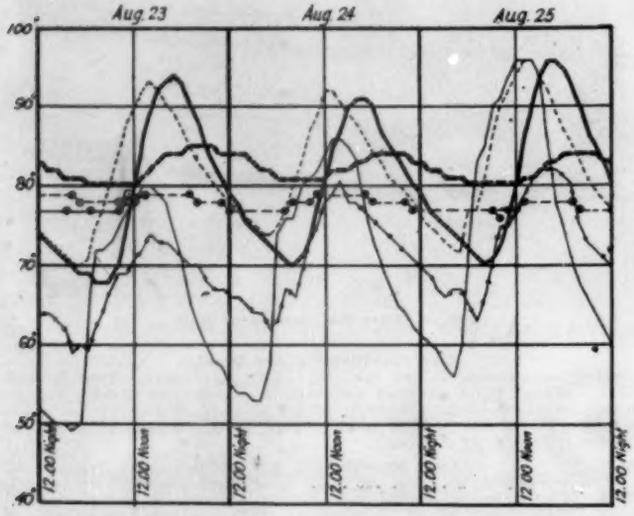

Aug. 23
Aug. 24
Aug. 25
100°
90°
80°
70°
60°
50°
40°
12.00 Night
12.00 Noon
12.00 Night
12.00 Noon
12.00 Night
12.00 Noon
12.00 Night
– Description and Conventions –
Bulb "A" located at base of rail — Temperature Curve shown thus ----- A
Bulb "B" located at top of concrete — Temperature Curve shown thus ——— B
Bulb "C" located half way down in concrete base — Temperature Curve shown thus — — — C
Bulb "D" located at bottom of concrete base — Temperature Curve shown thus -o-o-o- D
Bulb "E" located in clay 2 inches below concrete base — Temperature Curve shown thus -o-o-o- E
Bulb "F" located on pole 10 feet above surface — Temperature Curve shown thus ——— F
Air temperature as shown by U.S. Weather Bureau thermometer located 218 feet above surface — Temperature Curve shown thus ——— G
When curves "D" & "E" coincide — Temperature Curve shown thus -o-o-o-

Fig. 8. Results of Temperature Tests for Three Days in August.

Case XII—Electric Arc Weld.

Ninety-one-pound 7-inch tee rail. ¾x20-inch plate. Two ⅞-inch bolts. Plates scarfed on upper and lower edges at 55° angle, scarfing ½-inch wide. Plates seam welded full length. Weld started to break at 80,000 pounds. Rail broke through flange and web at 90,000 pounds. Rail showed brittle structure.

Fig. 9. Location of Thermometers, Recording Devices Are in Box at Foot of Pole.

Case XIII—Electric Arc Weld.

Ninety-one-pound 7-inch tee rail. ¾x20-inch plate. Two ⅞-inch bolts. Plates seam welded 8 inches on top at center and 8 inches on bottom 1 inch from each end. Weld started to break on top and bottom at 90,000 pounds. Fish plates broke at 92,000 pounds.

Case XIV—Electric Arc Weld.

Ninety-one-pound 7-inch tee rail. ¾x20-inch plate. Two ⅞-inch bolts. Plates seam welded 8 inches on top at center and 8 inches on bottom 1 inch from each end. One bolt sheared; weld broke on top and bottom on both sides of joint. Plate broke on one side.

Case XV—Electric Arc Weld.

Ninety-one-pound 7-inch tee rail. ¾x3x10-inch splice bars bolted with 2 ⅞-inch bolts not welded. ¾x7x20-inch plate bolted to base with 8 ⅞-inch bolts. Plate seam welded to base of rail. One rail fractured through base and web in two places; fracture extended up into ball of rail; weld broke at joint and between the points of fracture.

Cases XVI to XX.

Ninety-one-pound 7-inch tee rail. Continuous rail. (In Cases XVI and XVII there was a 1-inch tie rod hole at the point of loading.)

Case XXII—Electric Arc Weld.

Ninety-one-pound 7-inch tee rail. ¾x3x10-inch splice bars bolted with 2 ⅞-inch bolts, not welded. ¾x7x20-inch plate seam welded to base of rail. Rail broke starting at the end of the seam weld on the base; welds did not break.

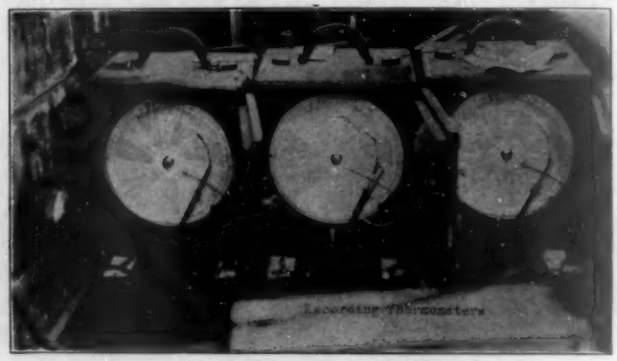


Fig. 10. Bristol Type Recording Thermometers.

Case XXIII—Electric Arc Weld.

Ninety-one-pound 7-inch tee rail. ¾x3x10-inch splice bars bolted with 2 ⅞-inch bolts, not welded. ¾x7x20-inch plate bolted to base with 8 ⅞-inch bolts. Plate seam welded to base of rail, except for 2 inches at each end of plate, which was not welded. Rail broke starting at the end of the seam weld on the base; welds did not break.

Case XXIV—Electric Arc Weld.

Ninety-one-pound 7-inch tee rail. ¾x3x10-inch splice bars bolted with 2 ⅞-inch bolts, not welded. ¾x7x20-inch plate bolted to base of rail with 8 ¾-inch bolts, using a 3x3-inch washer with every bolt. Plate seam welded to base of rail. Plate welded to base broke at the joint.

Case XXV.

Ninety-one-pound 7-inch tee rail. ¾x3x10-inch splice bars bolted with 2 ⅞-inch bolts, not welded. ¾x7x20-inch plate bolted to base of rail with 8 ¾-inch bolts, not welded. Bolts started to shear off at 83,600 pounds and continued until all bolts had sheared.

Case XXVI—Electric Arc Weld.

Ninety-one-pound 7-inch tee rail. ½x½x20-inch plate welded to ball of rail, top seam only. ¾x7x20-inch plate seam welded to base of rail. Rail broke starting at the end of the seam weld on the base; welds did not break.

Case XXVII—Electric Arc Weld.

Ninety-one-pound 7-inch tee rail. ¾x9-inch splice bars bolted with 2 ⅞-inch bolts, not welded. ¾x7x20-inch plate seam welded to base of rail. Rail broke starting at the end of the seam weld on the base; welds did not break.

Case XXVIII—Electric Arc Weld.

Ninety-one-pound 7-inch tee rail. Splice bars bolted with 2 ⅞-inch bolts, not welded. ¾x7x20-inch plate seam welded to base of rail and bolted with 4 ⅞-inch bolts, each bolt 2½ inches from on the base; welds did not break.

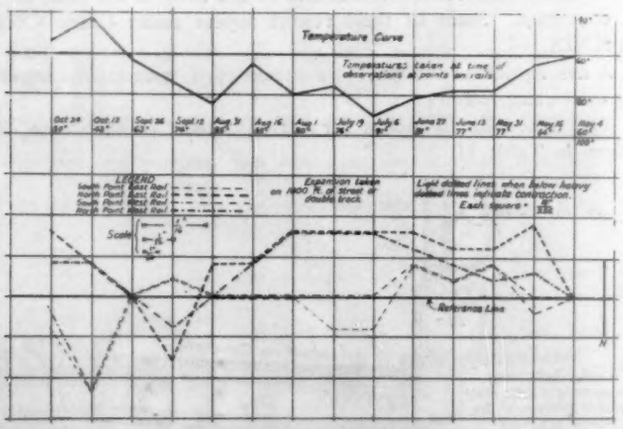


Fig. 11. Showing Maximum Expansion in 2⅝ Months About 1/16 Inch, 1,000 Ft. of Rail.

Case XXIX—Electric Arc Weld.

Ninety-one-pound 7-inch tee rail. 20-inch triangular splice bars seam welded top and bottom; 2 ⅞-inch bolts spot welded. Rail broke at end of splice bars; welds did not break.
ends of plate. Rail broke starting at the end of the seam weld

Practically 75 per cent of the 9,450 seam welded joints installed to date have been tested electrically by means of an American Steel & Wire Co. bond testing outfit and of these, one was found

defective due to inferior workmanship and six special work joints which should have been bonded and welded, were only bonded. The latter was due to carelessness. The joints tested have a conductivity of between 100 and 145 per cent of the conductivity of straight rail.

The subject of seam welded joints—in fact all types of welded joints brings to the fore the much discussed subject of expansion joints.

During February, 1920, the Bureau of Standards issued its Technologic Paper 62, entitled "Modern Practices in the Construction and Maintenance of Rail Joints and Bonds in Electric Railways," in which appear replies received from forty-two electric railways in answer to the twenty-six questions asked.

The twenty-fifth question was "What are the maximum and minimum temperatures to which your welded joints are subjected?" There were ten replies to this question and the data given therein varies over a wide range. The Bureau of Standards make the significant statement that the "answers to this question as given * * * are no doubt based upon guesses or estimates. In no case it is stated that they are taken from experimental observations."

As this subject is of unquestioned importance to the users of welded joints, the Department of Street Railways determined to make some experimental observations which would at least give some index of the actual conditions. For that reason three two-pen Bristol type seven-day chart recording thermometers were purchased and four bulbs were inserted in the pavement, one under the pavement and on on a neighboring pole. These thermometers were installed August 20, 1921, and while it is too early to procure anything other than a preliminary record, the data given in Fig. 8 gives an idea of what to expect during warm weather. Fig. 9 and Fig. 10 show the place where the thermometers are installed and the type of thermometer. It is anticipated that when these thermometers have been in use for one year, a complete and reliable record will be available.

The twenty-sixth question in the aforesaid Technologic Paper was "With what types of joints and under what conditions do you use expansion joints in your rails?" From the six replies to this question, it can be inferred that expansion joints are not necessary in paved streets, although the proof for the same is lacking. This matter came up last spring when there was occasion to remove the temporary back filling at a certain street intersection preparatory to installing the special work. The difference in the air temperature between midnight preceding the street opening and 10:00 a. m. was in the neighborhood of 40 degrees F. and at 10:00 a. m., when the back filling was entirely removed, the straight rails had buckled so that it was necessary to cut three-inch sections out of each rail in order to bring the tracks back to line. From calculations based upon the co-efficient of expansion of steel and the number of degrees rise in temperature, the increase in the length of the rails should have been a small fraction of an inch. It was suggested as a possible explanation that, when the back filling was removed, the steel rails and concrete base had moved in from both directions an amount sufficient to account for the three-inch increment in the rails.

In order to determine whether or not the road bed and rails move with changes in temperature, a road bed test was devised. This consisted of placing two marks, one thousand feet apart on one rail of each track and referencing them with respect to marks on the curb and in the sidewalk. The maximum movement of the rails for a maximum change in temperature of 30 degrees F. over the period from May 4, 1921, to September 26, 1921, was approximately 1/16 of an inch, which is within the limit of error of the transit used in making the sights. It is proposed to continue this test throughout the winter to see what the effect is with lower temperatures.

On account of the rail breakages which occur with welded track, and for the most part away from the joints, it is of the utmost importance to ascertain what happens with rails buried in pavement as far as expansion and contraction are concerned. The reason advanced for the breakages in the rails is generally that of faulty welding whether the break occurs in the joint or a foot away. The engineers in charge of this work are of the opinion that in any welded track a certain amount of adjustment is bound to take place during the first year after the joints are welded and this adjustment manifests itself either in joint failure or rail breakage. It is quite possible that the space between the joint plates and the webb of the rail permits of sufficient expansion and contraction of the rail to preclude the chance of failure at that point with the result that the stress is transferred to the straight rail adjacent thereto. This is merely conjecture, but the Department of Street Railways intends to make a series of tests with the idea of ascertaining the amount and direction of expansion and contraction with straight rails and with joint both in and out of pavement.

These tests will consist of anchoring the test rails longitudinally and measuring the expansion and contraction by means of Universal Dial Test Indicators, under different temperatures. There are also at the laboratory for chemical analysis and microphotographing, certain test joints which we have made. The results of these tests are not available as yet and for that reason are not included herein.

General

It must not be inferred that this paper is intended as an exposition of the methods and manner of joint welding used by the Detroit Department of Street Railways, but rather as a means of clinching the argument that service records and a complete discussion of the policy to be followed will develop the best type of rail joint whether it be the seam-welded or some other, with resultant benefits to the electric railway industry as a whole.

In passing, it might be well to state that better results have been obtained with welding operators who knew nothing of welding until they entered the employ of the Department of Street Railways.

An operator who had used the so-called long arc found it difficult to use the short arc and it was a bigger nuisance to train him than a novice. The same thing is true of the operator who had been trained in acetylene welding.

It is suggested that laboratory tests be made to determine the proper type of welding wire to be used, as this is of the utmost importance.

In closing, attention is again called to the importance of service records.

CATALOGS WANTED

A request has been received from Tolnai Vilaglapja, Budapest, Hungary, VII., Dohany-Utca 12 for catalogs covering all soldering and welding tools and apparatus.

NEW HEADQUARTERS FOR WILSON WELDER

The general offices of Wilson Welder & Metals Co. have moved from Bush Terminal to 132 King St., New York. The new quarters will accommodate the factory, warehouse and demonstration room. Shipments will be made from the stock carried at the new address.

"WELDITE" WELDING RODS

"WELDITE" is the trade name for a line of welding rods recently offered to the welding industry by the Chicago Steel & Wire Co., of Chicago. The welding qualities of this rod are attributed to a peculiar method of testing developed by the manufacturers. Considerable success has attended preliminary sales campaigns and this company has plans under way for gradually enlarging the line and thereby extending its activities in the welding trade.

PROCEEDINGS *of the* AMERICAN WELDING SOCIETY

33 West 39th Street, New York

Officers and Directors
AMERICAN WELDING SOCIETY
1921-1922

S. W. Miller, President
J. W. Owens, 1st Vice President
C. A. McCune, 2nd Vice President
W. E. Symons, Treasurer
M. M. Kelly, Acting Secretary
Comfort A. Adams, Director, American Bureau of Welding

S. W. Miller, Chairman, Executive Committee
W. E. Symons, Chairman, Finance Committee
W. T. Bonner, Chairman, Meetings and Papers Committee
C. A. McCune, Chairman, Membership Committee
Herman Lemp, Chairman, Revision of Constitution and By-Laws Committee.

INCREASED BUSINESS AS RELATED TO THE CUTTING AND WELDING TRADE.*

By Thomas H. C. Allen

I TRUST that this subject is of interest to you all. It is vital to most business organizations today. We have reached the day of strong competition, of the survival of the fittest. Additional business is going to be obtainable. The organizations equipped to go after this business and handle it properly after they get it, are going to forge ahead. The rest are going to drop behind, perhaps out of the game. To organize properly, no detail can be overlooked.

First—Manufacturing costs must be cut to the bone.

a—Labor must be cut but not too much. Each man must do a man's work each day.

b—In an apparatus shop piece work is preferable.

Second—Overhead must be squeezed, until it is as unobtrusive compared with the past few years, as a wet sponge clasped tightly in the palm of the hand compared to its normal size.

This is a ticklish point and often hits the source of the idea. This source must be big enough to carry the idea through unselfishly.

With manufacturing costs and overhead boned down, we approach our third point—S A L E S—

Here we get to the marrow of increased business and this is the subject I want to go into more thoroughly tonight.

We must increase our sales in order to increase our business. These sales must be profitable sales in order for us to exist. How are we to make more sales, and at the same time profitable ones? We have two ways to accomplish this end. First, increased consumption by equipments already sold. Second, increased consumption by sale of additional equipments.

The first one of these points is going to offer the largest field in the near future. Under this point comes repairs or replacement of old equipment. Due to the present economic trend among manufacturers this is going to appeal more strongly than the purchase of new outfits.

Now, how are we going to tackle sales? There is only one way. This is through our sales organization. (Through personal experience I have found a real sales organization in your line to be the best form of advertising) I am going to approach our sales organization from the point of a gas manufacturer. I firmly believe that a gas manufacturer should sell cutting and welding equipment and use this equipment as a wedge toward installation and increased consumption of his gas or gases. It is true, that oxygen and also combustible gases can be sold as sugar. The gas business is still in its infancy, however, and should not be allowed by the gas manufacturer to be placed on the shelf beside sugar. Each gas manufacturer must increase his business. To do so, he must take a vital interest in apparatus, salesman, but it is not absolutely essential. This knowledge of a customer's business enables the salesman to talk with a customer its installation and upkeep. To do this he must give SERVICE.

Now let's build up our sales organization about this word SERVICE. The manufacturer who gives real service to the cutting and welding trade, will increase his business. The one who tries to increase his business, by cutting his price below that of competitors, injures not only himself, but the business as a whole. Cutthroat competition drives prices below cost, and is ruinous to all. Make your price right. Not too high, not too low. A price that will enable you to make money, which is what you are in business for. Then hold to this price and get back to this word SERVICE. Hire and train your sales force with this word uppermost in your mind. Now let me suggest the following division for your sales force.

FIRST—General Sales Manager.

SECOND—District Sales Manager.

THIRD—Salesmen

FOURTH—Demonstrators

You must have your General Sales Manager as the natural head of your sales organization. For the same reason you must have District Managers because in each territory some one must be looked to for the final word.

Your salesmen and demonstrators come directly under the supervision of your District Manager. Your District Sales Managers are not placed in a territory for the purpose of sitting in the office, but are put there to work. This is true as well in the case of your General Sales Manager. Your whole sales organization must be built up of workers—honest workers. In hiring salesmen, allow me to suggest the following points for consideration.

Fitness—First and most important in the requisites of the salesmen is absolute honesty. If a salesman can convince a customer that he is square and is telling him the truth at all times, he has won half of his battle with the customer. A customer likes to deal only with straightforward, honest men in whom he can have absolute confidence. If a salesman can win a customer's absolute confidence the rest is easy.

Other points of consideration are: Education, Address, Appearance, and the following:

Knowledge of the Business—Without knowledge of the business a salesman must run more or less of a bluff. In doing this, he is most apt to lose a customer's confidence which is, as outlined above, the most essential requisite for a salesman. Therefore, knowledge of his own business is essential to a salesman. Knowledge of his customer's business is also a great help to a in his own language, as it were, and this often wins a customer's confidence very quickly.

*Paper read before American Welding Society, Pittsburgh Section, Pittsburgh, October 19, 1921.

Salary—Salesmen should be paid a salary commensurate with their ability and time of service.

Bonus—A Bonus system should be worked out. There are so many that I will not go into this in detail. The amount of money the Company has invested in each District, however, should be figured accurately. The Company should receive a fair return in the way of profit on this investment before any salesman should receive a bonus. The salesmen's bonus should be paid in each territory only out of funds in excess of a fair return to the Company in that territory and should be pro rated in accordance with this amount of excess returns.

Results—A new salesman should be given time to find himself. This may take two or three months. After this period of time, results should be expected and demanded, existing business conditions taken into consideration. A Sales Manager should be so careful in making his selection of salesmen that any man he selects should warrant at least two or three months' trial.

Duties of the salesmen—Should follow customer's service and cylinder situation—

Each salesman should make it his personal business to know that each customer in his territory receives the proper service.

Each salesman should see that the customers in his territory are turning cylinders over properly. A list should be available to him at all times showing the total number of cylinders each customer has in his possession. By comparing this list with the amount of gas used by the customer, and by studying the customer's location as regards the length of time it takes him to get deliveries of gas, it can readily be decided as to whether or not the customer is cooperating properly in the turn over of cylinders. If the customer is not cooperating properly it should be the salesman's business to obtain his proper cooperation.

Lack of red tape—simple reports, but reports that fill the bill—A salesman's report forms should be about 5 by 7 inches in size. This size can be carried in the salesman's coat pocket and is, therefore, convenient and at the same time large enough to cover the situation. This form should be in triplicate. The salesman should mail the original to the General Sales Manager at the home office of the Company, one copy to the District Office out of which he is working, and retain one copy for his own reference. By mailing the original copy direct to the General Sales Manager at the home office, the General Sales Manager can keep in direct touch with what each salesman in the organization is doing, can hear his story direct without having to go through the District Office to obtain this information. At the same time, the salesman feels that whatever he is doing and whatever he has to say is brought directly before the General Management of his Company and does not have to go through devious routes with the chance of its never reaching headquarters.

Preliminary training of salesmen—The same salesman should handle both gas and apparatus. It is not necessary for more than one salesman to call on any customer in regards to these items as they are used as one and the same, and the proposition should be handled for this reason, by one man. Two men calling on the same customer simply confuse the situation.

It is not absolutely essential that a salesman understand the methor of gas production, though the more knowledge the man has of his own business the better.

It is absolutely essential for a salesman to understand the operation and upkeep of cutting and welding equipment. For this purpose, the following procedure in connection with new salesmen has proven very successful:

First, give the salesman a complete cutting outfit and the services of a demonstrator, send him to a large scrap iron yard where he will be able to find most classes of cutting to do. Let the demonstrator break this salesman into cutting just as if he were instructing an operator of a customer to whom equipment had been sold. The salesman should then do cutting work in this scrap yard from one to three weeks. It would not be necessary for the demonstrator to stay with the salesman probably more than one or two days to start with. The demonstrator should return to the scrap yard, however, from time to time and the salesman should continue to cut there until such time as the demonstrator feels that the salesman has become a good average cutter on all classes of cutting found in the scrap yard, such as boilers, steel girders of various thicknesses, if possible up to 8 and 10 ply material, heavy axle and billet cutting, etc.

Second, the salesman should then be placed in a large steel foundry and again instructed by the demonstrator on riser cutting. Two days of cutting in the foundry will probably be enough after his experience in the scrap yard. The cutting of steel risers is so entirely different from the cutting of steel plate, girders, etc. that the salesman should as outlined be instructed separately on this class of work.

Third, welding is a trade and a man can hardly become an efficient welder in six months to one year's time. If you are going to employ salesmen, therefore, who are not trained welders, it would be entirely too expensive to instruct them efficiently in welding before starting them out at their regular work. It is a good plan, however, to let salesmen don overalls and work in a welding shop on various classes of welding for about one week after finishing his course in cutting.

Fourth, after completing the above course, a salesman has a pretty good understanding of the uses of cutting and welding equipment. He has become familiar with the troubles an operator comes up against in the use of this equipment. He should now be put in your general repair department for one week and allowed the work with your regular repair men, under their instructions, on the repair of your cutting and welding equipment. This course in repair of equipment should, as outlined, follow the instructions in the actual use of the equipment. This is an essential point.

Fifth, this salesmen's training course, therefore, takes from three weeks to one month. This time and expenditure on the part of the Company is more than warranted by the general results obtained from this course. (It might be well to state here that in choosing demonstrators, men should, if possible, be selected who are of proper caliber for salesmen. Many of the best salesmen in the cutting and welding line have, one time, started as demonstrators.)

Direction or directing of Salesmen:

Each salesman should be given a definite territory and should be allowed to work that territory exclusively. (There may be exceptions to the above in the case of railroads, etc., though ordinarily it is the best policy to follow the above to the letter. Each salesman should be made to stand on his own feet and obtain results. Let him understand that results are expected. Then the less actual interference and red tape on the part of the management the better. The management should, however, follow up carefully the work of each salesman as to service he is rendering customers, the new customers he is adding to his territory, and the amount of gas consumed each month by each customer. Should a customer's consumption of gas fall off, the salesman handling that customer should be in position to advise the reason. This consumption of gas for each customer can readily be kept both in the District and General Offices on a card of the following type:

A large card about 8x12-in. should be used. The customer's name and address should head the card, then across the top of the card, the months of the year should be shown with dividing line between the months of the year running to the bottom of the card. At the extreme left of the card, the days of the month 1, 2, 3,—down to 30, 31 should be shown consecutively and cards should be ruled in accordance with these days in the month. Then the District Office and the General Office can readily enter the number of cu. ft. of gas shipped to this customer under the proper month and under the proper date. A quick glance at this card will immediately show whether the customer is maintaining, increasing or decreasing his regular consumption of gas.

Relation of salesmen to demonstrators and general service department. The Service Men or Service Department in each de-

fined territory or District should come under the supervision of the salesmen in that territory or District. Demonstrators should be used as service men. At such times as the demonstrators are not busy making actual demonstrations, they should spend their time exclusively on service work. Each demonstrator should make out a report in triplicate, size same as salesmen's report, color different, and each demonstrator should send his original report direct to the General Sales Manager, one copy to the District Office and one copy should be retained by him for his reference. As in the case of the salesmen, therefore, each demonstrator feels that his services and whatever he has to say are coming directly under the eye not only of the District Management, but of the General Management of the Company. This, as in the case of the salesmen, is a spur towards better work because it absolutely insures a square deal and proper recognition for each man.

When a demonstration, either competitive or non-competitive, is made, both salesman and demonstrator should be on hand. The salesman and demonstrator should work separately except at the time of actual demonstrations.

Scope of salesmen's work (both apparatus and gas) one salesman can and should handle apparatus, oxygen, and whatever combustible gas is employed by his company. These three items are really so correlated that they should not be handled separately as regards selling organization. Apparatus should be considered in the light only of a means to more gas business. For this reason, your apparatus should be the best obtainable.

This apparatus can be made to stand the complete expense of the selling and demonstrating organization but should not be made to show profit over and above this expense.

Systematic checking of calls—Regarding a systematic method of checking calls on desirable customers.

First, as in the case of gas consumption, a service report should be kept separately for each customer both in the District and General Offices. This can be kept very simply on a small card which has the months of the year across the top, followed by the name of the customer, his address and then with 12 to 15 headings for date, name of salesman or demonstrator making call, and remarks. As each salesman's or demonstrator's reports come into the District and General Offices, this card is filled out as to date of call, name of man making call, and remarks. A small signal tag is then clamped at the top of the card over the month of the year during which the call was made. The General Office or District Office, glancing over these cards when filed in the proper container, can see at a glance whether these signals are moving to the right in accordance with the months of the year. If the month is March, all cards with signal clamped over January at the top of the card can be readily drawn from the file and notice given to the salesman handling that customer that service has not been rendered that customer since such and such a date. Each customer should be called on either by a salesman or a demonstrator at least once each month and the salesman should so direct his demonstrator that their calls fall successively and not together. The salesman will not have very much time for actual examination of equipment or apparatus of the customer, but he can find out by asking questions whether or not the apparatus of the customer is working satisfactorily. If the customer is having trouble, the salesman may be able to adjust the equipment immediately. If he is not able to do so, he should immediately have the demonstrator or service man call on this customer and put their equipment in first class shape.

Repair Kits—The demonstrator or service man should carry with him a small kit containing the necessary tools for making adjustments on equipment and a complete line of small repair parts. These small repair parts cost the company so little that they can afford to allow the demonstrator to install a washer here, a little packing in another place, and whatever minor repairs are necessary, without charge to the customer. If a repair of moment is necessary, such as a new head to a torch, the demonstrator should then advise the customer to forward same immediately to the Company's nearest repair department. When the customer finds that service of this sort is being rendered by salesmen and service men, both your salesmen and service men will receive a hearty welcome and their calls will be looked for with pleasure by the customer. The customer will realize that he is obtaining real service from your Company. His apparatus will, as a whole, remain in good shape and give consistent and continual service. You will find it very much easier to hold your customers, not only on apparatus but on your essential gas products.

Salesmen should not waste their time or their Company's time calling on customers whose gas business will be of little or no moment to your Company. If salesmen's bonuses are based on equipment sold, they would have a tendency to scatter equipment broadcast through each district in absolute disregard of the above.

A salesman can readily sell lots of cutting and welding equipment to very small users whose gas business will not be worth handling. It must be borne in mind at all times that the gas business is what you are really after. Therefore, drive this fact home with your salesmen. Make them realize that your profits come from gas and not apparatus and base their bonuses, as previously outlined, on your profits. Then follow up the work of your salesmen enough to find out that they are actually going after customers whose gas business is worth while.

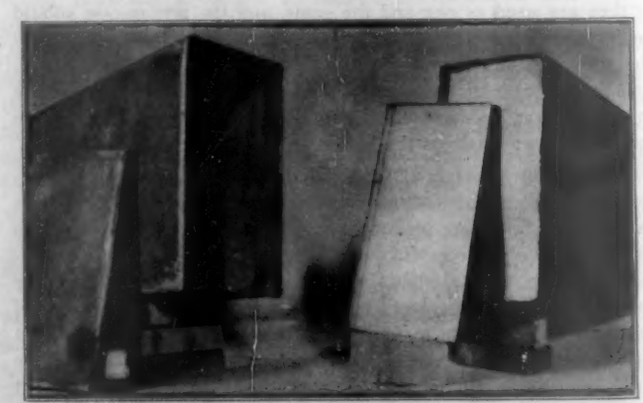
The above outline in regards to service is then applicable. If your salesmen go after and obtain the business of a lot of customers whose gas business is not worth while, then your service work at the rate of one call per month per customer would cost too much to carry out. A customer should either be worth giving the proper service to or he should not be considered a desirable customer.

Small customers who come after you to supply them with gas should not be turned down if their credit is satisfactory but they should not be carried on the regular service lists and they should be called on only at such times as they request service.

RECLAIMING ICE CANS BY WELDING

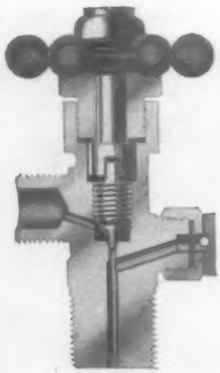
The galvanized iron tanks used in the manufacture of artificial ice have to be leak-proof or they are not suited to the service required of them. However, they are necessarily so used that leaks and breaks tend to develop, and unless these can be repaired satisfactorily the damaged tanks are of no further use or value excepting as so much scrap iron.

An El Paso (Texas) ice manufacturer has found a way of salvaging tanks that would otherwise have to be sold as junk. The bottoms of the damaged tanks—where the leaks and breaks first occur—are cut out, and new bottoms of galvanized iron sufficiently oversize to admit of bending in a quarter-inch flange are set in and welded to the lower edges of the tank walls at the rivet line with the oxy-acetylene torch.



Ice Cans Reclaimed by Welding.

The illustration shows (on the left) a 300-pound size ice tank with the bottom cut off and (on the right) one in which the



MORE Burdett valves will be made and sold in 1922 because Burdett valves give satisfaction. The model pictured above, the Burdett Standard High Pressure Valve, is especially favored in the gas industry. It is a high grade single seat valve, at a popular price. Just note a few of the construction features which have won nation-wide popularity:

1. A swivel mounted, tapered seat tip, made of monel metal.

2. It does not twist nor wear, so there are no new seats to buy and no "gas leakage" complaints from customers.

3. The plug is connected directly to the stem, making a "stronger" valve.

4. No broken valve stems to replace.

5. No twisted valve tongs and spreading of split valve plugs. Burdett research and Burdett workmanship have produced here the sturdiest and most economical high pressure valve on the market.

Gas Producers are Invited to Ask Us for Complete Details and Prices

Burdett Manufacturing Co.
309 St. Johns Court Chicago, Ill.

Any Weld or Cut is Easy with a Fidelity Torch

Fidelity torches are members of a nationally known family of

FIDELITY PRODUCTS

which embraces torches, regulators, apparatus and supplies for use in all kinds of machine shop repair practice, in connection with High and Low Pressure gases.

Wherever there is a job of Welding, Cutting, Lead Burning, Soldering, Brazing, or Decarbonizing, there is a Fidelity Torch or Outfit best adapted for it.

Our special torch standards of Economy in Gas consumption in Operation-Convenience, and Safety embraced in the patented features of our torches, the result of a complete knowledge of torch manufacture — distinguish the Fidelity torches from all others.

Fidelity No. 1 Garage Special.

This outfit is adapted for use by the garages, machine shops, etc. where only welding is required.

The outfit consists of:

No. 1 Welding Torch with 7 tips.
No. 1 Oxygen Regulator with 50 lb. working pressure gauge.
No. 1-A Acetylene Regulator with 50 lb. working pressure gauge.
12½ ft. White H.P. Hose.
12½ ft. Black H.P. Hose.
4 Hose Clamps.
1 pair Goggles.
1 7-in. Wrench.
1 1-A Acetylene Adapter.
1 2-A Acetylene Adapter.
1 lb. ¼-in. Norway Iron Welding Rod.
1 lb. ¼-in. Low Carbon Welding Rod.
1 lb. ¼-in Cast Iron Welding Rod.
1 lb. ¼-in. Cast Aluminum Welding Rod.
1 lb. ¼-in. Cast Bronze Welding Rod.
½ lb. Cast Iron Flux.
½ lb. Brass and Bronze Flux.
½ lb. Aluminum Flux.
Packed complete in steel case.

List Price, $83.60

Handled by the Auto Supply, Hardware, Electrical and Machinery Supply jobbers in the United States and Canada.

If your jobber doesn't stock it, write us for catalogue, prices and discounts.

FIDELITY PRODUCTS

Manufactured by
FIDELITY BRASS MFG. CO.
1001-1011 W. Washington St., Chicago, U. S. A.

new bottom has been welded into place. The work was done by the Southwest Ox-welding Co., of El Paso. The bottom is of 14-gauge galvanized iron, seam welded and reinforced and chilled at the corners to give added strength. The operation is comparatively simple and inexpensive, compared to the cost of new cans, but care needs to be exercised in handling the work to avoid warping and buckling of end and side sheets, in order that the ice cakes may be readily removed. This is accomplished by first anchoring the bottom in place with tack-welds at the corners and at intervals along the edges, after which the remaining spaces may be easily welded up. It is claimed that the tanks salvaged in this manner are stronger than and will outwear new riveted tanks.

The superiority of many articles after being repaired by welding has led to the adoption of welding in their initial production, as it has been found that the welding not only gives better results but contributes to speed and economy of manufacture. This is especially true of riveted and lock-seam work in sheet metal, and it would appear that manufacturers of tanks for use in ice plants might profitably make use of the oxy-acetylene process in the same manner.

Who's Who

ELMER H. SMITH

Mr. Elmer H. Smith, president of Smith's Inventions, Inc., and of the Commercial Gas Co., of Minneapolis, has for many years been actively identified with the oxy-acteylene industry. The accompanying photo of this modern factory speaks for the success Mr. Smith has had in his chosen line of work. In a recent interview with Mr. Smith he was asked how he happened to get into this industry, as he is known to have made a successful start in the electrical field. With a reminiscent smile he said, "Lack of funds." Then, in explanation: "I had been attending the University of Minnesota, studying electrical engineering, and the few hundred dollars I had

Plant of Smith's Inventions, Inc.

saved had all but disappeared. At this crucial moment, when worry about the morrow's quiz in calculus sank into insignificance along side of the problem of getting the next meal ticket, it was suggested by a friend that a wonderful opportunity was at hand for an ambitious young man in the charging of auto lighting cylinders with acetylene. Cost of gas, 40 cent; selling price, $3.00; profit, $2.60. With rosy hopes of filling a hundred cylinders a day at a profit of $260.00 per day I went to work arranging for my immediate start in the new venture.

"However, being more or less of a student I thought it would be no more than right to get a little better acquainted with my new friend, Acetylene, and if possible to get on more intimate terms as long as we were to go into partnership. In pursuing my acquaintance, imagine my digust when I found that my partner turned traitor and positively refused to do his share, after I had spent hours planning for our mutual benefit. My friend Acetylene positively refused to

submit to the indignity of allowing himself to be generated under a pressure of 350 pounds per square inch, and emphatically stated that if our diplomatic relations were to continue I would have to kindly observe this peculiarity in his temperament.

"This unreasonableness on the part of Mr. Acetylene Gas together with other complications quickly terminated my almost sudden flight to affluence, but in the meantime I had made the acquaintance of the soulmate of Mr. Acetylene Gas, Miss Oxygen, and in an eastern city I saw with my own eyes a pieece of steel cut in two and then welded again. This was wonderful, and opened up new possibilities. On arriving home I approached a large brazing repair shop, and the owner promptly threw cold water on the idea that this new process could find a place in competition with other methods. He said it was too expensive, that New York or Chicago could probably support one of these 'oxo-ackteline' machines, but not the Twin Cities.

"To make a long story short, the money for a complete plant, acetylene generator, chlorate of potash oxygen plant, and three oxygen drums was borrowed, and the business of oxy-acetylene welding repair work officially started in the great Northwest under the name of Northern Welding Co. Within a year I started to make up new kinds of torches and developed the Vulcan line, which together with the oxygen plant was sold to an eastern company in 1917.

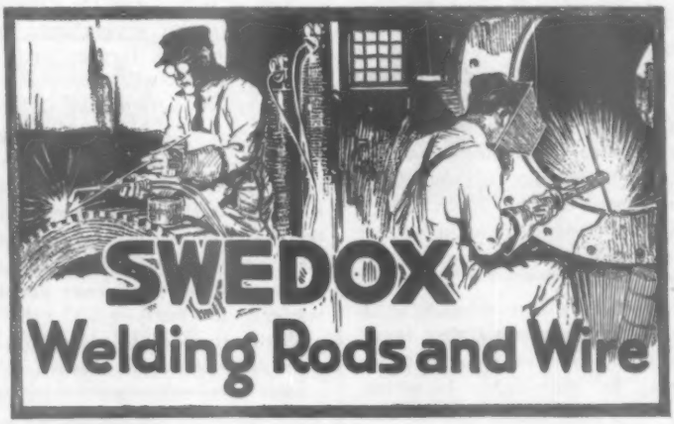
"In 1918 I was scheduled for gas service in connection with the development of gases, but months of waiting and idleness failed to materialize this position, and the peculiar fascination of the oxy-acetylene industry lured me back to it, and I now firmly believe in the saying, 'Once a welder, always a welder.' In conclusion, I don't know of any line of endeavor that offers more opportunity than the 'oxo-ack-teline.'"

Swedox Welding Rods and Wire

SWEDOX welding wires and rods are the pioneers of all welding wires. For over 12 years they have been recognized as the foremost and most reliable of all products. Their use in practically every known industry has proven their superiority. The quality maintained has never been equalled.

NONOX SWEDOX
LEKTROX SWEDOX
GAS CARBOX
ARC CARBOX

VANOX
NICKOX
KROMOX
RAILOX
CASTOX



SQUARE □ CASTOX
MANGANOX
ALUMINOX

BRONZOX
BRAZOX
TOBIN BRONZE
COPPER ALLOY RODS

CASTOX-BRONZOX
ALUMINOX FLUXES.

Immediate Shipment of any quantity large or small from either our Chicago or Detroit warehouse. Unequalled service—we ship the same day.

FREE trial samples furnished upon request. Our experts will solve your welding problems. Send them to us.

CHICAGO, ILL.
127 N. Peoria St.

Central Steel & Wire Company

DETROIT, MICH.
Warren & Bellevue Ave.

20 Years' Oil Burner Experience (Kerosene)

HAUCK

PREHEATERS

Will reduce your Welding Costs to the very Lowest Minimum, as well as Producing a Perfect Weld. A saving of from 30 to 60 per cent in Oxy-Acetylene alone makes the purchase of a Hauck Preheater a highly profitable investment.

Write for Bulletin No. 127.

HAUCK MANUFACTURING CO.
122 Tenth St. Brooklyn, New York

CESCO HELMET

Door hinged at arrow, all helmets are fitted with
Essentialite Lenses

Style "P"

Sold by All the Leading Jobbers of Equipment
Manufactured by

CHICAGO EYE SHIELD CO.
2300 WARREN AVE., CHICAGO, ILL.

PROGRESS OF A. S. M. E. BOILER CODE

(Continued from page 21)

welding for unfired pressure vessels was materially exaggerated. The test evidence, however, and the strong arguments always lay with experimental research work and it is, therefore, hoped and urged that all manufacturers who can possibly make investigations on the type of welded container they are manufacturing, that they put same to thorough tests and to a point of destruction, and submit the results of these tests to the Boiler Code Committee.

"Real conscientious and sincere work is now required on the part of the Boiler Code Committee and they look to manufacturers who have constructed and built satisfactory welded pressure containers to co-operate with them, and give them all possible assistance and knowledge of their best practice and experience: consequently further developments and a resulting proper code will be dependent upon further development of codes by the committee, and unquestionably further hearings will become imperative."

Concerning supports for pressure containers referred to in paragraph 11, page 6, of the report, we observe that in all class "A" vessels, it will be necessary that the entire exterior and interior of the vessels may be thoroughly inspected. This matter was under serious advisement and considerable objection offered. Such unfired pressure vessels used in refrigerating plants will require no interior inspection because ammonia does not attack any of the metals that we use in making welded containers; we, therefore, oppose the making of any such provision for interior inspection and we will not require any hand holes or man holes, which to our way of thinking are very objectionable. In determining the proper supports or supporting points of welded ammonia containers, and for that matter other pressure containers of the welded type, we favor the use of a certain ratio (diameter of vessel to length of same for determining the number of supporting points).

With regard to lugs or brackets used to support welded pressure containers of any type, you will observe paragraph 12 of the report, necessitates that such lugs or brackets shall be properly fitted to the surface to which they are attached; in this connection we feel there should be no objection to the welding on of such supporting lugs or brackets.

Amplifying our earlier letter concerning the use of the A. S. M. E. stamping of welded unfired pressure vessels hereafter, permit us to repeat that we are in favor of using such A. S. M. E. stamp providing the rules refer to a WELDING CODE and not to the Boiler Code, because the Boiler Code itself makes no reference or provision for welding.

Paragraph 17 provides that tank builders' stamp shall not be covered by insulating and other material, and, of course, we would favor that such stamp should be attached to the outside portion of the insulation, because some of our pressure containers may necessarily be covered with insulating material.

In writing our former letter we have overlooked taking exception to the very important paragraph 9, page 7, which provides that "The Boiler Code Committee would be pleased to receive suggestions as to the best way of placing the responsibility for any welded structure on the manufacturer:" and it suggests further that possibly the manufacturer be required to guarantee the tanks which they make against accident and property risks. This, is indeed, very objectionable and we feel sure that you will agree with us that this is not fair and we absolutely oppose the furnishing by manufacturers of any gauarntee other than workmanship and material as is the usual practice. Boiler manufacturers and those furnishing other types and classes of equipment, operating under pressure are not expected to assume liability for consequental damages, and we can do no more. This is entirely a commercial matter between the buyer and the seller, and is beyond the province of any code making power. We feel sure that fellow members will agree that this paragraph is serious and objection must be raised to it at an opportune time in order that the final code will not include any such drastic provisions.

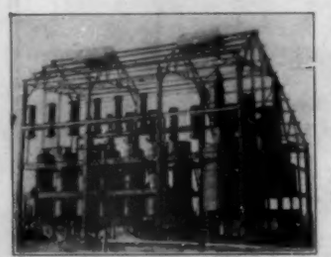
Of course, paragraph 23, of the tentative report of the Boiler Code Committee is really the basis for the entire discussion and the evidence submitted from experimental investigation already, as well as the further data to be submitted by others and the experience together with the recommendations and suggestions to be offered for consideration when developing further such fair and proper code of rules and regulations will strongly refer to the safety of employing any form of autogenous welding in the making of suitable unfired pressure vessels for the various forms of service. Where it refers in paragraph 23, that such autogenous welding may only be used on vessels for making tight joints where it is not relied on for strength is erroneous, as we have all types and classes of such pressure containers utilizing welded seams and joints, which are amply safe and have proven to be so from experience at hand and the service they have rendered for many years.

With reference to paragraph 43, page 14, under subject of dished heads to which we have referred in our former letter, permit us to add that the general opinion expressed prevails not to favor the inclusion in the code of any limits or requirements as to crimping or skirting.

With further reference to paragraph 46, page 14, we would favor the setting up of a ratio of diameters; that is, diameter of nipple to diameter of vessel for determining the maximum size of nipple which may be welded into the shell of any container and that flanged or flared nipples for setting into the shell opening and welded flush only be specified for such limits of above ratios. These limitations of nipple sizes, however, should apply to vessels only and not to headers.

REFRABRICATING STRUCTURAL STEEL WITH A TORCH

The use of the oxy-acetylene torch for demolition of steel-frame buildings is so common as to be very generally known, but its use in erecting structural steel is sufficiently rare to occasion special comment whenever it occurs. Even rarer, we believe, is the refabrication of steel under the circumstances and in the manner detailed in the following instance:



The Bonner Everett Co., of Laurel, Miss., recently erected a large turpentine still, and the structural steel to be used in building the permanent housing for the plant was found, on its arrival, to be badly off-size and off-shape. Owing to the isolated situation of the plant, it was impracticable to return the steel to the mills and enter a re-order. Either the cost of the transportation or the delay would have been considerable; together they were prohibitive. In the emergency the contractor, who had an oxy-acetylene welding and cutting outfit on the work, decided to use it for refabricating the steel, cutting the overlengths, welding necessary sections onto short lengths, burning rivet holes where needed, and heating members with the gas flame where reshaping was required. The work was accomplished with surprising despatch, and the structure was completed in less time than would have been required to get new material on the ground.

This may be only another instance of the emergency value of the oxy-acetylene torch, or it may, as some engineers believe, be prophetic of a day when the process will be employed very extensively in fabrication of structural steel. Some progress has already been made in this general direction in the oil fields, where welding has been successfully employed in the erection of light steel structures from tubing.

Classified Ads

Help Wanted—75c per line, minimum 4 lines.
Jobs Wanted—4 lines free.
Other Ads—$1.00 per line, minimum 4 lines.
Counted 8 words to line. Add 6 words for keyed address.

Sales Agents

Excellent territory open for aggressive sales agents to sell Milburn Welding and Cutting apparatus. This apparatus is the product of 20 years' specialized development and manufacturing experience in the acetylene industry. Supported by trade journal advertising and intensive mail campaign. Stocks carried in principal cities, immediate factory shipments, normal prices for highest quality of apparatus, Milburn guarantee.
Preference given to men with welding experience or firm with welding trade. Write in full confidence regarding territory desired and your facilities for handling it.

THE ALEXANDER MILBURN CO.,
1420-1428 W. Baltimore St., Baltimore, Md.

A one-story factory is soon to be erected on Los Angeles Street by the Eastman Welding Company, Los Angeles, Cal.

Will Sacrifice—Welding shop, located in heart of Aurora, Ill., established 11 years. Practically no competition. Good trade. Owner retiring. For particulars address F. N. Gary, 600 Main Street, Aurora, Ill. Telephone 1585-R.

Position Wanted—Thoroughly experienced electric arc welder; 7 years experience. Prefer portable outfit. Married man. Good references. Address 21, care The Welding Engineer.

Position Wanted—Electric welder with 5 years' experience in boiler work, shipbuilding and general repairs on tractors, etc. Address R. E. Elliott, Upland, Cal.

Position Wanted—Electric arc welder with 9 years' experience; 2 years as foreman. Would like demonstrator or foreman position in United States or South America. A-1 references; both railroad and shipyard. Address 22, care The Welding Engineer.

Cast NORTHEX Iron WELDING RODS

The controlling features in the purchasing of material today are quality and price.

Standardized equipment and advanced molding practice enables us to produce the finest welding rods at a minimum cost.

Our quality is highest—Our prices lowest.

Write for Quotations

NORTH BUFFALO HARDWARE FOUNDRY
745 Hertel Avenue Buffalo, N. Y.

The Oxy-Thermalene Method of Welding, Cutting, Brazing, Etc.

ACETYLENE OIL GAS PRODUCER the gas of greatest efficiency, economy and SAFETY. The only class of its kind. Saves 25% on gas and oxygen.

FIRST CLASS REFERENCES
Special Welding MACHINES, guaranteed no flash back cutting and welding torches, and supplies.
Triangle Mfg. Co., 314-322 W. 43rd. St., Chicago, Ill.
Phone Boulevard 1347

OXYGEN HYDROGEN
SEAMLESS STEEL CYLINDERS
I. C. C. SPECIFICATIONS
WM. WHARTON JR. & CO., INC.
30 Church Street NEW YORK CITY

THE "ALTERNARC"
Portable Cutting and Welding Machine
"Carry It to the Work"
THE ELECTRIC ARC CUTTING & WELDING CO.
152-58 Jelliff Ave. Newark, N. J.

WELDING ROD HOLDERS
FOR THE OXYACETYLENE WELDER
75 CENTS EACH, 3 FOR $2.00
Dealers Price on Application
C. SORENSEN 18 EAST 16TH STREET CHICAGO, ILLINOIS

BOOKS ON WELDING
Write for list of books on welding.
If it's in print we have it.
THE WELDING ENGINEER
608 S. Dearborn St. CHICAGO, ILL

AGENTS
Sell THE WELDING ENCYCLOPEDIA during your spare time or as you call on the trade. Write today for our plan.
THE WELDING ENGINEER
South Dearborn Street CHICAGO, ILL

LIBERTY ALUMINUM SOLDER permanently repairs Crank Cases, Aluminum auto hoods, auto bodies, manifolds—in fact anything made of aluminum. Guaranteed to give satisfactory results. Laboratory test shows 12,000 pounds tensile strength. Price $2.00 the pound, 10 pounds or over $1.75. Shipment cash with order or C. O. D. except where satisfactory credit relations established.

Order Today — Jobbers Wanted in Every City

LIBERTY WELDING & MFG. CO.
4200-4208 Grand River Avenue, Detroit, Mich.

DISTRIBUTORS
Big Three Welding & Equipment Co.,
Corner Broadway and Jennings, Ft. Worth, Texas.
St. Paul Welding & Manufacturing Company,
174 West Third Street, St. Paul, Minn.

Finish Your Welds With a "WODACK"
PORTABLE ELECTRIC GRINDER

You will also find the "WODACK" Portable Electric Drill equally handy in your repair shop.
Both tools are fitted with the "WODACK" universal motor and will operate on A. C. and D. C. current. ***Write for descriptive circular.***

Manufactured by **Wodack Electric Tool Corporation**
Office and Factory: 27 South Jefferson St., Chicago, U. S. A.

ATTENTION, WELDERS

Make big money repairing Scored Cylinders and Cracked Water Jackets by the **EVER STAY PROCESS.** We **GIVE** you complete instructions on making tools and applying **EVER STAY METAL** with an initial order of **EVER STAY METAL AND FLUX.**

EVER STAY METAL ..... $2.75 Per Pound
EVER STAY FLUX ..... 1.00 Per Bottle
EVER STAY SOD LOOM, for Aluminum ..... 2.75 Per Pound

This metal sold on a Money Back Guarantee. All orders shipped C. O. D. No orders shipped less than two pounds of metal. Prices F. O. B. Omaha, Nebr. Jobbers wanted in every city.

Distributors for Rego Welding and Cutting Apparatus.

EVER STAY SALES COMPANY
1501 Jackson Street, OMAHA, NEBRASKA

CURRENT WELDING LITERATURE

BOILER WELDING REPAIRS IN ENGLAND—The National Boiler and General Insurance Company of Manchester, England, recently issued instructions to all its inspectors covering the details of boiler repairs by autogenous welding. This company will sanction repairs to parts in compression and, within limits, to parts that may be in tension but are adequately stayed. In the latter case the extent of the defect and the degree of staying will have an important bearing on the question whether a repair by welding is allowable. These instructions are written in a practical way and amply illustrated.—The Boiler Maker, December.

EFFECT OF OXY-HYDROGEN CUTTING ON LOCOMOTIVE RODS, by Arthur F. Pitkin—Brief report of test cut made on 5¾-in. solid slab forging. Physical tests and chemical analysis having shown no change in metal due to effect of flame, micro-photographs were taken of each test piece. Conclusion: With $\frac{1}{16}$ to $\frac{1}{8}$ in. left for finishing, the quality will be the same as the solid metal of the original forging.—American Machinist, Dec. 15.

REDUCING COSTS BY ELECTRIC WELDING—Statement of the savings effected by nine manufacturers who use electric resistance welding machinery on production work.—Machinery, January.

ANGULAR WELDS, by Marcel Piette—An illustrated, semi-technical article on the strength of angular welds made on sheets and tubes. Greater strength can be secured by decreasing the sharpness of the curve at the angle.—Revue de la Souture Autogene, Paris, November.

STEEL PLANT MAINTENANCE BY AUTOGENOUS WELDING, by Walter Petry—A general description of the Thermit, Oxy-Acetylene, and Electric Arc welding processes, and their principal uses in the steel plant, with interesting discussions centering on the selection of welding rods and wire.—Journal of the Association of Iron and Steel Electrical Engineers, December.

CAST IRON WELDING, by L. A. Eubanks—Short, elementary discussion of the points to observe in welding cast iron.—Garage Journal, January.

HANDY SHOP KINKS FOR THE OXY-ACETYLENE WELDER, by David Baxter—Suggestions for the student welder, for saving time and trouble.—American Blacksmith, December.

THE OXY-ACETYLENE TORCH, by David Baxter—Instructions to the beginner on the care of the torch.—Acetylene Journal, January.

WELDING IN AUTOMOBILE REPAIR WORK—A survey of the field for welding broken automobile parts.—Canadian Welding Journal, December.

WELDING THE WORLD'S LARGEST FLUME—The stotry of the welding of the giant 300-foot penstocks of the Chippewa Canal—Canadian Welding Journal, December.

PRACTICAL APPLICATION OF WELDING, by A. M. Barry—A general treatment of the possibilities of the three welding processes as applied to commercial uses, with especial reference to marine and boiler work.—Canadian Welding Journal, December.

THE SCIENTIFIC SIDE OF WELDS, by E. A. Atkins—A technical description of the structure and properties of cast iron welds, resistance welds, contact welds and spot welds, with specifications for iron and steel welding rods, and brief treatment of welding non-ferrous metals. Illustrated by microphotographs.—Acetylene and Welding Journal, London, December.

ASSEMBLY AND USE OF WELDING AND CUTTING APPARATUS—Instruction book published by Torchweld Equipment Company, Chicago. Contents: Production of the gases; Welding materials and supplies; gas pressure regulators; "Torchweld" welding torches; Assembly of welding equipment; The welding flame; Fundamentals of welding; General information for welding; Welding shop suggestions; General repair work; Steel welding; Production work on steel; Boiler welding; Cast iron, copper, brass and aluminum welding, "Torchweld" cutting torches; Metal cutting; Lead welding; Carbon burning; Important points to observe. Illustrated by photographs and diagrams. 72 pages, bound in heavy cover board. Supplied free to all users of Torchweld apparatus.

CATALOG W-21—Published by Fidelity Brass Mfg. Co., Chicago. Describes and illustrates torches, outfits, equipments and supplies for use with Oxygen, Acetylene, Hydrogen and other gases in the various processes of welding, cutting, soldering, brazing, lead burning and decarbonizing. 32 pages.

SPARKS—House organ of Bastian-Blessing Company, Chicago. Current issue features, a description of the Rego "Little Six" welding outfit.

ELECTRIC WELDING, by H. S. Marquand—204 pages, cloth bound book, with bibliography, illustrations, tables, and index. A manual of the theory and practice of electric resistance and electric arc welding. The book treats of the development of the various welding processes, the properties of metals considered from the welding point of view, equipment and machinery necessary and applications of the different processes. Testing welds, characteristics of arc fusion, and welding costs are important topics. Such definite facts and data are set down as will be a valuable guide to those who wish to have a competent knowledge of electric welding in all its phases and applications. Published by Benn Brothers, Ltd., London, England. Price 12/6d.

Lejon BRAND *"Well Worth a Trial"*
GENUINE SWEDISH
ACETYLENE WELDING RODS
FROM STOCK MILL SHIPMENTS
B. Dieden & Co., Inc., 50 Church St., New York

REPAIR SCORED CYLINDERS, WATER JACKETS, ETC. WITH LIBERTY IRON METAL. We sell complete outfit for doing this work including initial supply of metal. Satisfaction guaranteed. Price $25.00 Complete. Full instructions with every outfit. Write us for further information as to profits, etc.

LIBERTY WELDING & MANUFACTURING CO.
4200-4208 GRAND RIVER AVENUE DETROIT, MICHIGAN

NOW YOU CAN ADVERTISE YOUR WELDING SHOP

Read how you can do this cheaply and well. Read double page explanation in the November issue of The Welding Engineer. Hundreds of welders will begin using the wonderful new advertising material in February and March.

FREE SAMPLES NOW READY. Send for your free copy showing in full size how your advertising will look. Address: The Welding Promotion Co., Suite 501, 574 Fifth Ave., New York City.

Begin The New Year Right

By Using Proper Appliances

The B. D. M. Co.'s Brazing Stand will give you the most satisfaction for all your pre-heating; welding or brazing work. Equipped with two powerful Blowpipes, and having all connections on the Stand, ready to connect to your main gas and air supply.

Catalog "B.X." is full of interesting appliances for the work shop. Free for the asking. YOUR ADDRESS, PLEASE?

BUFFALO DENTAL MFG. CO.

Buffalo, N. Y., U. S. A.

WELDERS MOULDING COMPOUND

Every Oxy-Acetylene and Electric Arc welder has undoubtedly felt the demand for a fire resisting compound which could be moulded into any desired shape. When building up metal around holes in castings, and where welding is necessary through a machined part, such as a bearing, much time and machining can be saved in addition to making a neater appearing job by employing such a compound. Carbon blocks and rods have their field, but it is very limited. "Welder's Moulding Compound" can not only be used wherever carbon has been, but it has a much wider field. Moulds can be made for any missing lugs or parts and new ones cast that have all the appearance of having been machined. Aluminum parts may be "backed-up," preventing the collapse of the metal when heating.

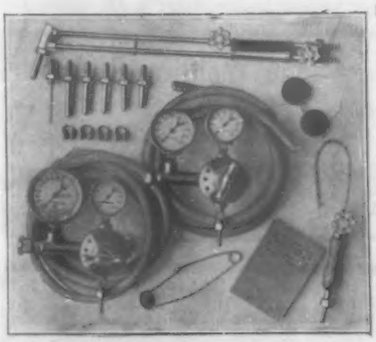
For aligning broken sections, whether large or small, the usual shimming process may be forgotten and much time saved by using this compound as a cushion for the work. It can be used in hundreds of different ways, over and over again—it don't wear out. The wide-awake welder will appreciate its true worth.

5-LB. CARTON, WITH MANUAL OF INSTRUCTIONS - - - - - $2.50

Manufactured only by

UNITED STATES WELDING CO., Inc., Minneapolis, Minn., U.S.A.

MAKERS OF FAMOUS "U. S." WELDING AND CUTTING APPARATUS



No. 2 Superior Welding and Carbon Burning Outfit, equipped with double gauge regulators $69.30

No. 1 Superior Welding and Carbon Burning Outfit, equipped with single gauge regulators $49.10

Superior Oxy-Acetylene Machine Company

Manufacturers of
Welding and Cutting Apparatus, Torches, Regulators, Gauges, Lead Burning and Carbon Burning Outfits, Acetylene Generators. Welding Supplies of Every Description.

No. 2 Superior Welding and Carbon burning outfit consists of:

1	Superior Type "B" Welding Torch, passed upon by the Underwriters. This Torch is heavily nickel-plated, with metal handle, equipped with 7 two-piece copper Welding Tips. No. 1 tip can be used for Radiator Work. This Torch is a Non-Flash Torch and will not flash out under any ordinary circumstances	$16.00	
1	Carbon Removing Torch	1.50	
1	Safety Torch Lighter	.50	
1	No. 30 Safety Front Oxygen Regulator with one 3,000-lb. Gauge, registering cu. ft. and one 300-lb. Gauge	24.00	
1	No. 35 Acetylene Regulator, equipped with one 300-lb. Gauge and one 50-lb. Gauge	10.00	
1	Length of 5-ply Oxygen Hose, 12½ ft.		$ 1.50
1	Length of 5-ply Acetylene Hose, 12½ ft.		1.50
4	Hose Clamps		.20
1	Pair Welding Goggles		.50
1	Instruction Book		1.00
1	Adapter		1.50
8	Cast Iron Rods, 1 Pound Cast Iron Flux; 2 Brass Rods, 1 Pound Brass Flux; 2 Aluminum Rods, 1 Pound Aluminum Flux; 10 Steel Rods		3.00
	Price of Outfit No. 2		$60.20
	Cutting Tip can be furnished for above Outfit to cut steel up to 2 in. in thickness		5.00
	Packed in carrying case, extra		3.00

Repair all makes of equipment.

WRITE FOR MONTHLY PRICE SHEET AND CATALOG
Agents wanted in unoccupied territory.

Superior Oxy-Acetylene Machine Co.
Hamilton, Ohio, U. S. A.

General Electric Co. arc welding sets, electric and gas engine driven, hand and automatic operation, on easy payment plan if desired. Full line of welding accessories carried in stock.

Page-ARMCO welding wire, acetylene and electric, cut in 36-in. and 14-in. lengths, or on metal reels for use on G. E. automatic welder.

Welding Service Company Hudson Terminal—30 Church Stree NEW YORK CITY

QUASI-ARC SYSTEM

We Manufacture:

A. C. & D. C. Welding Sets

Also Weldtrodes for

Mild Steel
High Carbon
Manganese
Cast Iron

L. W. 110 V. WELDER

Gives Machinable Weld

QUASI-ARC WELDTRODE CO., INC.
Peekskill, New York

LET'S GO as this "Welding Foreman" who severed his connections with a World Wide Concern to go into business on his own personal financing and initiative.

AND GO by choosing material best by test, the same as this welder. Knowing success depended upon the reliability of material and technique, experience demanded he specify "MOREY" Oxy-Acetylene Welding FLUXES.

AND GO by making your services demand recognition as the "Welding Foreman," whose purchases for the past five years were:
1916, $270.09 1917, $403.30 1918, $558.88 1919, $487.56 1920, $506.40

AND GO SPECIFY—"MOREY FLUX" on all orders, where reliability dependability and quality are the most valuable assets to prosperity, as proven by a "Welding Foreman" with a reputation.

MOREY FLUX & CHEMICAL CO.
PARKESBURG, PENNSYLVANIA

Established 1912 *Incorporated 1915*

HOS

ALUMINUM WELDING FLUX

A "HOSKINS" PRODUCT

HOS Aluminum Welding Flux melts at a lower temperature than does aluminum, spreads evenly over the surface to be welded, and prevents oxidation, thus insuring a perfect joint. By using it you save time and trouble. You also save money in flux cost, for HOS Flux gives best results when used sparingly.

High grade dealer accounts wanted

HOSKINS PROCESS DEVELOPMENT COMPANY
4035 W. Kinzie Street CHICAGO, ILLINOIS

BUCKEYE

Aluminum Solder	$1.00 #
Cast Iron Flux	.35 #
½ '' C. I. Rod	.06½#

These items as well as all other supplies and REGO equipment that we handle carry our "No Reservation" Guarantee. On that basis, can you go wrong by sending us a sample order?

The Buckeye Welding & Supply Co.
1544-52 W. 6th St. :: :: Cleveland, Ohio

CAST IRON RODS

— Soft and Clean —

QUALITY GUARANTEED

Also

RODS, WIRES AND FLUXES
For Welding All Other Metals

Prices on Application

BIERMAN-EVERETT FOUNDRY CO.
133-153 So. 20th St. Irvington, N. J.

IMPERIAL WELDING AND CUTTING EQUIPMENT

OXY-ACETYLENE PROCESS

A new mixing principle, a regulator that accurately controls gases, the greatest working range ever covered by ONE torch —are exclusive IMPERIAL features. Write for catalog.
Imperial Brass Mfg. Co., 517 S. Racine Ave., Chicago

High Silicon Cast Iron Welding Rods

Cast Aluminum Rods.

Grey Iron and Aluminum Castings of all descriptions.

WRITE FOR QUANTITY PRICES.

The Iron City Foundry Co. Hamilton, Ohio, U. S. A.

Strand

FLEXIBLE SHAFTS

Grind and Finish your welds with Strand Flexible Shaft Grinders.

Made in several sizes.

N. A. STRAND & CO.
549 W. Washington Blvd. Chicago

EASY WAY WELDING TRUCK

If you are interested in increasing the efficiency of your welding department you should consider the EASY WAY WELDING TRUCK.

Frame made of angle, well braced, riveted and set in perfect balance. Bottom holder formed of heavy plate steel. Wheels 33 inch with 3 inch tire. Axle 1¼ inch round steel. Chain holders are easily adjusted, fitting any size tank and can be released by one or two turns of adjusting screw.

Welder can handle 300 foot acetylene and 250 foot oxygen tanks with perfect ease—the large wheels and balance do it. Can not turn over.

Price, $15.00

M. DESMOND MFG. CO., 318-322 St. Louis St. EDWARDSVILLE, ILL.

AIRCO OXYGEN AND ACETYLENE SERVICE

IS GOOD SERVICE

Airco was used to a large extent in rebuilding this steamship which was shortened to admit of passage from the Great Lakes to an important eastern dry dock.

No Shortage on the Big Jobs

Large welding and cutting operations often necessitate emergency orders for Airco Oxygen and Airco Acetylene.

You need not fear a shortage of supply when undertaking these large projects, because a nearby Airco Distributing Station is prepared to handle efficiently your rush orders for Airco Oxygen and Airco Acetylene.

"Airco Oxygen and Acetylene Service is Good Service" under all conditions.

AIR REDUCTION SALES COMPANY

Manufacturers of Airco Oxygen, Airco Acetylene, Airco Welding and Cutting Apparatus and Other Airco Products

Home Office:
342 MADISON AVE.,
NEW YORK, N. Y.

Airco Plants and District Offices:

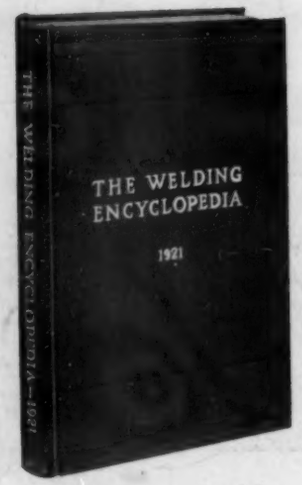
Atlanta	Jersey City, N. J.
Bethlehem, Pa.	Johnstown, Pa.
Boston	Madison, Ill.
Brooklyn	**Minneapolis**
Buffalo	**New York**
Chicago	**Oklahoma City**
Cleveland	**Phi'adelphia**
Coatesville, Pa.	**Pittsburgh**
Defiance, O.	**Richmond**
Detroit	**Seattle**
Emeryville, Cal.	**St. Louis**
Gloucester, N. J.	Warren, O.

Airco warehouses at intermediate points

Bold type indicates the city also contains an Airco District Office. Address correspondence to nearest District Office.

Send for Airco Booklet "The Technical Engineer's Judgment of the Oxyacetylene Process." Mention THE WELDING ENGINEER when writing.

The WELDING ENCYCLOPEDIA is the most complete and authoritative book you can get on Autogenous Welding



326 Pages
375 Illustrations
Bound in Cloth
Price $5.00

HERE is a book written for the purpose of giving the welder complete and accurate knowledge of his work. It supplies the very information he needs. The properties of all metals are explained in words easily understood. The welder is told how to handle all these metals by all welding processes, so that the parts united will retain their original properties. The Welding Encyclopedia is more than an instruction book, it is a complete reference work on all phases of autogenous welding. Kept in the shop, where it is easily accessible, it will pay for itself many times over by answering troublesome questions.

CONTENTS

1. Illustrated encyclopedia covering all words, terms, and trade names used in welding.

2. Oxy-Acetylene Welding—Aluminum, Steel, Cast Iron, Copper, Brass, Bronze. (Full instructions for welding each of these metals.)

3. Electric Arc Welding.—Two illustrated chapters on this process.

4. Electric Resistance Welding.—Includes Butt Welding, Line Welding, Percussion Welding and Spot Welding.

5. Thermit Welding.—The most complete treatise on this process ever published.

6. Use and Misuse of Oxy-Acetylene Equipment. —Tells how to get the best results from apparatus and how to avoid costly accidents.

7. Boiler Welding.—An important subject for the welder to study.

8. Heat Treatment of Steels.

9. Rules and Regulations.—What can be welded and what cannot be welded. Rules also govern the installation and operation of equipment.

10. Charts and Tables.—A fund of welding information at a glance. Includes color chart showing colors at various temperatures.

11. Condensed Catalogs.—Up to date information about the leading makes of welding apparatus and supplies. The Buyers' Index is a convenient and reliable guide to the man who purchases or recommends welding apparatus.

1-a

The Welding Engineer Publishing Co.
608 S. Dearborn St., Chicago, Ill.

Gentlemen:

Please send me a copy of The Welding Encyclopedia, for which find enclosed five dollars. I understand that I may keep it for five days for examination and if it is not satisfactory I may return it and you will refund the purchase price.

Name .....

Street .....

Postoffice .....

Send the Coupon Today

Order with this coupon enclosing check or money order for five dollars. If, after keeping the book five days for examination, you are not satisfied with it, you may return it at our expense and the purchase price will be promptly refunded.